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VOL. LXIII MARCH 5, 1926 No. 1627

CONTENTS

Address on the Occasion of the Dedication of the New Hospital of the University of Michigan: DR. W. S. THAYER 237

The Figure of the Earth and the New International Ellipsoid of Reference: W. D. LAMBERT 242

Charles Vancouver Piper: Dr. A. J. PIETERS 248

Samuel Marx Barton: JOSEPH K. ROBERTS 249

Scientific Events:

The Smithsonian-Chrysler Expedition to Africa; A Field Course in Geology at Princeton University; Endowment for the Henry Phipps Institute; Regional Meeting of the American Chemical Society at Madison; A Scientific Study of Educational Work in Mississippi 249

Scientific Notes and News 251

University and Educational Notes 255

Discussion and Correspondence:

Bleached Flour and Neutralized Cream: CHARLES H. BRIGGS, PROFESSOR C. H. ECKLES, DR. H. W. WILEY. *Science not in it:* DR. EDWIN E. SLOSSON. *Letter from the Principal Authority of the Fundamentalists:* GEORGE MCCREADY PRICE 255

Scientific Books:

Hutton's Natural History of Crystals, Wyckoff's Structure of Crystals and Bragg's X-Ray and Crystal Structure: DR. WHEELER P. DAVEY 259

Special Articles:

Pleistocene Features of Southern New England: PROFESSOR H. L. FAIRCHILD. *Light Localization in Ctenophores:* YO K. OKADA 260

Science News x

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ADDRESS ON THE OCCASION OF THE DEDICATION OF THE NEW HOSPITAL OF THE UNIVERSITY OF MICHIGAN[1]

LET me thank you, ladies and gentlemen, for the opportunity which your officers have placed before me in inviting me to address this gathering. It is a privilege to take part in such ceremonies at one of the first and greatest of those American universities which have shown that the people of a self-governing state will support an institution in no way second to those older private bodies in this and in other countries, which have long prided themselves on offering to teacher and student freedom of thought, study and utterance; which have afforded them liberty to pursue truth for truth's sake.

The guiding principles of a university should be liberty and tolerance. The true university is a society of students and scholars, searchers for truth. Only such can be real teachers. The mechanical retailer of the assertions and convictions of others has no place in a university. He can not be a teacher in the true sense of the word. He can not be a successful teacher even in a secondary school. 'Tis one of the gravest defects of our secondary education in this rapidly growing country that with the wealth of opportunity open to all there are sadly few students or scholars engaged in secondary teaching. Too many are young people retailing information, teaching up to the limits of their knowledge, who have no thought of making their immediate occupation a career. Secondary teaching is but a passing incident in their lives, a means to acquire the wherewithal with which they may pass on to other opportunities which to them are more tempting.

What a difference it would make to our boys and girls were they, in the secondary schools, thrown into association with real students and scholars, as is commoner in some of the older countries. Those individuals who have had the rare good fortune to fall under the quickening influence of a scholar in their early life, and those teachers who have had the opportunity to meet, later, with such men, know full well the enormous influence that the scholar in a secondary school may have on the character and the mind and life of his pupils—and indirectly on the future of the state.

A true university should seek primarily in all branches for those men and women who have shown

[1] Given on November 19, 1925.

themselves to be disinterested students and who seem to be especially qualified to profit by the advantages offered by its libraries, its laboratories, its unions, its opportunities for association with other superior men. To these men and women the university should offer its confidence, and then—freedom. One more privilege it always offers, the greatest of all privileges, that of association with those other students who are entering the field possessed of that blessed gift

. . . . . .
Kind nature's richest dower,
Youth, the fair bud that holds life's opening flower,
Full of high hopes, no coward doubts enchain,
With all the future throbbing in its brain,
And mightiest instincts which the beating heart
Fills with the fire its burning waves impart.

For association with the young is the greatest privilege of the teacher—the only vaccine against age and apathy. Only the student can be a real teacher; for only the student can inspire. And to secure the services of the student he must be offered opportunities for study. But there are students and students, and, in all branches of learning, one meets now and then with quiet, modest individuals with minds of the delicacy of fine lace work who can not work in the open, who can not commune with the many, who need protection and seclusion. Teachers in the ordinary sense they are not. Yet the influence of some of these men is precious. Opportunity and protection and freedom for an occasional delicate vessel of this sort it is the privilege of a university sometimes to offer.

Freedom from the cares of the world, liberty to pursue the search for truth in his own way, liberty of thought, liberty of utterance, these are perhaps the greatest gifts that a university can offer to its faculty—and to its pupils.

The other guiding principle of the university should be tolerance; tolerance without which the word freedom is but mockery. Intolerance is the child of fear, and fear is the son of doubt and incomprehension. The university should offer to its staff liberty to search for truth; truth can never be dangerous.

"But," say those in the terror of incomprehension and ignorance, "there are directions in which you may not search. For by that very search you deny the truth which is ours and is more precious than all else, our faith."

But the searcher for truth attacks no faith. He seeks for truth alone and he has faith that truth once revealed will prevail. But truth is often very hard to find. To him who possesses or feels that he possesses truth how can there be such words as doubt or fear? To doubt that truth will prevail is to doubt one's faith. The searcher for truth may doubt the faith of another, but he denies no man's faith. A poor and unworthy searcher for truth is he who attacks the faith of his neighbor, who lacks respect for the sincere belief of any man. Of this he is sure, that once revealed, truth will prevail, that truth needs no defense, that if, perchance, that which to his human vision has seemed to be a truth shall fade in the light of a new day, there yet remains hidden a greater, larger, purer truth for which with a wider horizon, his mind is open.[2] And if his neighbor blaspheme that which seems to him the higher truth, how shall that concern him? For has he not faith that he who blasphemes truth but lays bare his own littleness in the purer light which must, one day, burst even upon his blindness?

He who fears that the searcher for truth may destroy his faith, he who, possessing high ideals, fancies that this faith and these ideals may give way to anything that is not higher and broader and larger, thereby doubts and insults his faith. He who would seek to defend and protect those ideals by circumscribing the mental activity of his fellows not only insults his own faith, but stands forth as a cruel enemy to truth and progress and humanity. This is intolerance, a hateful beast of sordid ancestry.

The true university is the protagonist of liberty and tolerance and opens the way in its sphere to the search for truth. It attacks no faith. Fear it knows not, secure in the faith that new truths can lead us only into a higher and broader life. To the eager youth who seek to penetrate further and further into the great mysteries of life and death it says in the words of the wise old teacher and poet:

Take from the past the best its toil has won,
But learn betimes its slavish ruts to shun.
Pass the old tree whose withered leaves are shed,
Quit the old paths that error loved to tread
And a new wreath of living blossoms seek,
A narrower pathway up a loftier peak;
Lose not your reverence, but unmanly fear
Leave far behind you, all who enter here!

Truth needs no defense. Freedom, alas, may. And the true university through its tolerance toward all who are sincere should be the sword and the buckler of that liberty of thought and speech through which alone new truths will be revealed.

The opportunities and associations of university life you are now offering to the teacher and student of medicine and surgery, and 'tis well that it should

[2] *Cf.* Maeterlinck. Le temple enseveli, Paris, 12°, 1902, Charpentier, pp. 106; 110–112.

be so. Instruction in the art of medicine, to but relatively a few years ago, while often carried on under the wing of the university, was left largely to active practitioners of the art with few opportunities and little time to give to the study of its scientific aspects. But within the last century, and especially the last fifty or sixty years, the scientific basis of medicine has been greatly strengthened. For many years the fundamental sciences called into service in the study of medicine have been subjects for university study and investigation. Now at last we are coming to realize that even in the practical branches of the art the university must offer to a selected kernel of its staff the same protection, the same financial support, the same opportunities for research and study that it has long offered to the student in other branches of science and the liberal arts. As to the student of the classics you offer your libraries, as to the botanist you give gardens and laboratories, so here you are offering to the clinical instructors in your departments of medicine and surgery this great hospital in which they may study and practice their art. At the same time you are giving to a selected group of men who desire to give their lives to study and university work that financial support which may set them free from many of the burdens and cares of self-support and place them on a university plane with the student of the humanities and natural sciences. It is a great step forward, advantageous alike to the profession and to the community.

The practice of medicine has changed amazingly even in a period so short as that of one lifetime. Forty years ago on my graduation from college the time demanded for the examination of a patient by the best equipped consultant was but short; the methods of examination employed were such that they could for the most part be carried on in the consulting room by the examiner himself. The few additional special studies that had to be made were easily carried out. But what is the situation now? The patient who is suffering from some obscure complaint, trivial or serious, it is immaterial, tells his story to the physician. The examination may uncover few definite revealing signs. The physician is in doubt; there are many possibilities. What shall he do? What would be the ideal thing to do? The ideal thing to do would be to make a thorough routine examination of the patient just as one makes his own physical examination in the consulting room, a systematic study, anatomical and functional, from head to foot. This would mean observation in a hospital, the consultation of a considerable number of special students and would involve many complicated and expensive physical and chemical investigations of special organs, of body fluids, excretions and secretions. That which one might do in the attempt to make a complete study in any given case is almost unlimited. Where shall one begin? Where shall one stop? Many studies which are desirable in a complete survey are impossible for the general practitioner to carry out. Indeed, they may be wholly out of his reach. With the physician lies the responsibility of determining what examinations are necessary, what desirable, what superfluous. In him the patient places his faith; he must consider all the aspects of the situation; he must know how best to utilize the diagnostic machinery, simple or elaborate, which may be employed; he must consider the measures at his disposal, the means of his patient. The student must learn the significance and the relative importance of different diagnostic procedures, for upon him falls the responsibility of deciding that which is necessary.

It is important for the public that there should be centers in which such studies may be made under proper supervision. A university clinic like this should afford every opportunity to the teacher and student to pursue these studies. To the students it should afford the necessary opportunities to acquire certain fundamental conceptions as to the nature of disease and the principles of therapeusis that can be acquired satisfactorily only where the necessary scientific apparatus is at hand, as well as the required knowledge of the significance and relative importance of a great variety of diagnostic procedures. Many of these he may be unable to employ himself, but occasionally or more often he will be obliged to make use of them for the benefit of his patients. For the public, medical and general, it is desirable that there should be centers to which the practitioner may bring his patient for those special investigations and studies which are impossible other than in an institution with elaborate scientific equipment in the hands of highly trained and disinterested students.

It is needless to point out what an opportunity is offered in this connection to the unscrupulous and the venal. There are to-day many so-called laboratories and clinics more or less commercial institutions, in which examinations are made by men who are far from competent. An examination, even if well made, the results of which are improperly interpreted is worse than useless. Too often the doctor or patient is confused or deceived, the patient perhaps suffers, the public is bled. It is not easy for the practitioner who has not had a good basic training to appreciate the significance and the relative value of new and perhaps valuable diagnostic procedures. Commercial laboratories conducted by men of shallow general training are not a public safeguard; they are a liability.

That the well-equipped school of medicine should have in its medical and surgical departments a group of men who are well-salaried and afforded wide clini-

cal and laboratory advantages is, I think, becoming very generally recognized. These men are in a true sense university professors. Such a group of men is as valuable to the hospital as it is to the university. This truth is becoming more and more apparent to the intelligent public. An interesting example is the action, a few years ago, by the enlightened governors of a public institution which has for many years been conducted with unusual credit. The trustees of the Boston City Hospital having observed the value of university divisions in various private hospitals, deliberately, voluntarily and of their own initiative, established that model university division which is now presided over by Professor Francis W. Peabody. By so doing they have established in the hospital a scientific center of equal value to university, to city, to the hospital and its visiting staff and to the general public.

Such a division and such an association are invaluable to any large general hospital.

But it should not be forgotten that there is another element without which no hospital and no department of medicine is complete and that is a coordinate staff of expert clinical surgeons and physicians. The professor of medicine, the director of a university division of medicine or surgery, may and I think should be an experienced clinician or surgeon. But he can become so only through long experience in general or consulting practice of his art in all branches of society. Such experience may be offered by hospital in its public and private wards, but the experience is indispensable.

It takes many men to make a department of medicine or surgery—the adept in special branches as well as the experienced or skilled general surgeon or clinician.

What sort of man should be the director of a university department of medicine or surgery? As I have often said in public and in private there is no absolutely set type for a director of a university clinic; the essential thing is that he should be a learned physician or surgeon with a good scientific foundation and scholarly tastes, who is a good organizer and whose heart is in his work. He should in my opinion always be a man who has had a considerable and well-digested clinical experience. It is conceivable that such a man may have special interests, neurological, bacteriological, chemical, but if he is the right sort of man he will see that his clinic is complete. Ten years ago, in discussing the objections that had been raised by some to the establishment even of a nucleus of university professors in the clinical branches, I said:

> So far as the student goes, the danger that under the direction of a salaried professor, he may be given a training more purely academic and insufficiently practical seems to me small. In the first place, it has already been pointed out that the professor of medicine will doubtless be a man who has had a considerable clinical experience with patients in all classes of life, whose training has been by no means purely academic, and although some of his associates will perhaps be men who have not yet acquired the ripened experience which should be that of the head of the department, yet no one for a moment fancies that *all* the instruction in medicine and surgery will be given by the nucleus of teachers wholly dependent on their salaries. In every large clinic, and in every large hospital affiliated with a university, a considerable part of the instruction in general medicine and surgery, as well as in specialties, must be entrusted to men with or without salaries, who are more or less actively engaged in practice. The fancy that because the director of such a clinic and many of his assistants are no longer at the beck and call of the public, the student is to be regarded as deprived of the opportunities offered by association with men who have been or are engaged in active practice, is a misconception.

This seems to me as true to-day as yesterday. But there is a danger which may be mentioned; the danger of offering chairs of medicine and surgery to young men of special promise who after two or three years of internship have given the great majority of their time to the study of special problems which have held them aloof from active clinical work. These men may make admirable professors of medicine in the sense that they may have a thorough and sound conception of what a department of medicine should be. But at the time when they enter on their duties such men are not—and can not have become—trained or experienced clinicians. The responsibilities of the chair of medicine in a great university are heavy and I fear that for some of these men the professorship may bar the way to the acquisition of that experience necessary to make them finished diagnosticians or clinicians. To become a well-equipped diagnostician or clinician requires an amount of time spent at the bedside and in conference with patients that these men have not been able to give previously and are scarcely likely to be able to give in the future. Such men may be great administrators, profound students of a special branch, learned medical men, but, I am afraid, rarely great clinicians. In a properly organized clinic, it may be answered, these men will so select their staff that students and patients are offered association with the experienced clinician or surgeon. This may be, but, on the whole, it is I think unfortunate, especially for the professor himself, that he should be obliged to assume the duties of director of a large clinic at a time when he is not wholly at home at the bedside. I can not help feeling that the situation of

some men who, too early in their careers, are tempted to accept a professorship, may be rather tragic.

An associate professorship in a university division should offer priceless opportunities for the acquisition of competence in any branch of surgery or medicine. These foundations bring to the clinic men of special talent and training in special lines. But if a man desire to become a clinician or an operating surgeon, he can not, at the same moment, give the main part of his time to teaching and to the investigation of special problems which confine him to the laboratory and classroom. He must of choice and deliberately give years of his life to the intensive study of clinical problems. This opportunity the university should offer him, profiting the while by his special talents which are occupied in teaching and in research in the field of his special competence. But he should be protected from all unnecessary teaching while he devotes a large part of his time to the acquisition of clinical experience among patients in all classes of life. There is abundant room in the university school of medicine for the clinician and the student of special problems side by side. No clinician who is worth anything can fail to be pursued by the desire for research, but he must have daily and engrossing clinical duties if he is to be a clinician. The student of a special problem should not be required at the outset to teach subjects with which he is not wholly familiar. At the beginning of his career he must for a number of years give a large part of his time to clinical duties before he acquires that competence necessary for the general clinical teacher. He should be protected during those years in which he is not only pursuing his special studies but is also acquiring this necessary clinical experience, and during this period he should not be expected to bear the burdens of general clinical teaching. His most valuable contributions are for the time being in his special line.

A school with a purely university staff would be incomplete. It could not do its full duty to patient or student or staff. The patients would be deprived of the diagnostic and practical skill of men of larger experience and the student of instruction by such men. On the other hand, the burden of duties as instructors in an art in which they are not altogether at home would take the valuable time of specially trained men who should be protected in their investigations and offered opportunities, if they desire them, for the acquisition of that general clinical experience, highly desirable if not necessary for the director of a department. Too many duties in the way of general clinical teaching should not be forced upon these men too early in their career. The desirability of association with an experienced clinical staff should be generally appreciated. The university and the clinical staffs should be interdependent.

The problems of teaching of medicine and surgery are engaging. You in Michigan have had among you some of the most distinguished students in this country. I need not name them. Many are here today. One whom I have especially loved and honored has already spoken. The presence of these men has made Michigan one of the great schools. The efforts which the state and the faculty have made and are making will make it greater. You have had your critics. What an uninteresting school you would have had if you had not! But you have looked forward, and following the wise maxim of Candide, you have cultivated your garden.

And while we are working in our garden striving for better things, full of enthusiasm and hope, rejoicing at times, perhaps, in what we have accomplished, along comes our old friend with resigned air or cynical smile, and says: "Foolish man, you talk of your garden and even of the world as if 'twere a garden or a world of flowers. Wake up! Look about you! Is this a world of flowers? Is it not rather a world of weeds? And your very garden be it university or profession, what is the commonest thing in your garden, the flower or the weed? Is not your very garden in truth a garden of weeds?" And almost lovingly he directs our eye to the familiar, amusing or dreary or sordid and tragic picture of our omni-present neighbor, the weed.

Ah, entertaining whisperer of half-truths, how familiar is your picture! How well we know the back yards and the ash heaps and the tin cans and the waste iron and the neglected field. How well we realize that the bright flowers that illume the roadside and the meadow are but spots, islands amidst the riot of stubble and weeds among which they rise. And in the world of which we are members are we not but too familiar with the infrequency with which the human flower raises its head above the drab and dreary monotony of weeds?

But why dwell upon the weed? Is it not the flower that counts? What is it that fixes and freshens the eye of the traveler on the road of life, the dusty weed or the gleam of the flower? Are the labors of the botanist and the gardener in vain—the gardener who prepares the ground for the growth of the flower; the botanist whose transformations may bring a halo even to the lowly weed?

There are, 'tis true, some earnest and serious but rather ponderous brethren who fancy that they may sharpen the enthusiasm of the gardener and the botanist by dwelling on the unloveliness and the omnipresence of the weed. And then there are those,

usually rather young, who take a sort of perverse joy in pessimistic visions of the futility of life, and in the contemplation of the unlovelier characteristics of the weed, a shallow and sophomoric epicureanism. But why waste one's time in exaggerating or gloating on the unloveliness of the weed? Even the weed has its hour of charm. There is a moment at which even the weed flowers. And then is it not the weed with its modest blossom that time, the mind of the botanist and the hand of the gardener have transformed into the perfect flower? What if the botanist and the gardener in the beginning had been content with pessimistic or cynical contemplation of the unloveliness of the weed?

Consider the world of the middle ages and the renaissance. What remains to-day? Is it the picture of the sordid ignorance and vice and eternal discord of the population? Or is it rather the lofty naves and domes and graceful spires, the glittering jewels of Chartres, the tombs of the Medici, the harmonies of the painter's art? The weeds are long forgotten; the flowers remain, more radiant and more lovely in the tender light of receding years. It is the flower that counts. Is it not our function to feed and nourish and transform the modest and transient blossom of the weed into the more perfect flower? And if our neighbor choose to devote himself to the contemplation of weeds, and close his eyes to the flowers; if he choose to dwell upon the unloveliness of the weed rather than upon *its* flower; if he be blind to the circumstance that in its modest and blundering way even the weed is seeking for beauty, let us not be annoyed. So, somehow or other, in a devious way, is our perverse friend. It is the flower that counts. "Cultivons notre jardin."

W. S. THAYER

BALTIMORE, MD.

THE FIGURE OF THE EARTH AND THE NEW INTERNATIONAL ELLIPSOID OF REFERENCE

AT the meeting of the International Geodetic and Geophysical Union, held October, 1924, at Madrid, the section of geodesy of that union adopted a so-called international ellipsoid of reference, that is, it adopted certain parameters defining an ellipsoid of revolution which, among all such possible ellipsoids, was believed to represent the best, or perhaps merely the most convenient, approximation to the actual figure of the earth. The figure which this ellipsoid of revolution is intended to represent is not, of course, that of the actual physical surface of the earth, but the ideal *geoid*, an equipotential surface which coincides approximately with the surface of the ocean as far as the latter extends and which would exactly thus coincide if the disturbing effects of winds, differences of temperature, barometric pressure, etc., were removed. The geoid is continued in imagination under the continents and could be defined physically at any point by digging a very small sea level canal connecting that point with the ocean. The water in such a canal would rise to the level of the geoid.

Several questions arise in connection with this vote of the section of geodesy, among which might be mentioned: (1) Exactly what ellipsoid was adopted? For on this point it happens that some degree of misunderstanding is possible. (2) What was the purpose in adopting this international ellipsoid? (3) How closely does it represent the actual geoid? It is the purpose of this article to give some sort of answer to these questions and also to give for reference a few numerical magnitudes derived from the fundamental parameters adopted by the section of geodesy.

The two parameters defining the ellipsoid of revolution adopted by the section of geodesy are:

Semi-major axis (equatorial radius) = 6 378 388 meters
Ellipticity (flattening) = 1/297.

These figures are those deduced by Hayford[1] in 1909 from the deflections of the vertical then available in the United States, these deflections being corrected for topography and isostatic compensation. This recognition of the importance of isostatic compensation and its systematic use in deriving a figure of the earth marked a long step in advance. The importance of this piece of Hayford's work has been increasingly recognized with the passage of time and on May 26, 1924, he was awarded the Victoria Medal of the Royal Geographic Society of London "for conspicuous merit in scientific research." The further recognition accorded by the section of geodesy in adopting his figures as the dimensions of the international ellipsoid of reference came only a few weeks before the illness that caused his premature death on March 10, 1925.

The possibility of misunderstanding arises from the fact that, since these figures were given by Hayford, the international ellipsoid based on them has often and very justly been called the Hayford ellipsoid. The semi-minor axis, however, given by Hayford as 6 356 909 meters, differs by about three meters from that determined by a simple calculation based on the parameters adopted by the section of geodesy; these latter give

Semi-minor axis = 6 356 911.946 meters

1 J. F. Hayford, "Supplementary investigation in 1909 of the figure of the earth and isostasy." (Published by the U. S. Coast and Geodetic Survey.) 1910.

and this must be considered as the international value regardless of the value given by Hayford.[2] Or to state the matter in a somewhat different form, if the axes given by Hayford be taken as exact, the flattening comes out 1/296.959 instead of 1/297 exactly, as adopted by the section of geodesy.

This discrepancy between the two values of the minor axis is, of course, small in comparison with the uncertainty of the quantity itself. It is desirable, however, that there should be no misunderstanding about the dimensions of the international ellipsoid, especially because even a small inconsistency in the elements of the ellipsoid would lead to annoying discrepancies in the results of geodetic computations when two different formulas for the same purpose are used to check one another.

It happens that the parameters of ellipsoid of reference are the same as those adopted by Finland for its future geodetic work. Long before, at the Paris Conference[3] of 1911, the astronomers had adopted a flattening of exactly 1/297, based on Hayford's work, then but recently published.

The motives determining the adoption of the international ellipsoid of reference are well set forth in the report of the executive committee of the section of geodesy.

> There is no intention whatever of forcing upon nations that have their triangulations either long completed or well advanced a new ellipsoid upon which they must recalculate their triangulation. If they are in a position to do so, so much the better, but obviously they can not be compelled to do this and any ruling of this sort would remain nugatory.
>
> The international ellipsoid should be used in preference to any other:
>
> (1) In regions recently opened to geodetic work, for triangulations very recently undertaken or scarcely begun, the calculation of which could be easily recommenced, and for triangulations to be undertaken in the future.
>
> (2) In regions already covered by geodetic operations, when for any reason the work is to be revised.
>
> (3) Whenever for purposes of higher geodesy the deflections of the vertical are to be calculated with reference to a definite ellipsoid.
>
> It is thus to be hoped that the triangulation of the vast territories still to be won over to geodesy will all be calculated on the same ellipsoid and that some countries will make over their triangulation on the same system. Even though the homogeneity can not be complete, at least a long step will have been taken towards that unification of systems so much desired by geodesists, a fact which will make it easier to discuss and to solve a large number of important problems.

Item No. 3 of the quotation above suggests a distinction which it is well to bear in mind between the geographic and the strictly geodetic purposes of a geodetic survey. This distinction is illustrated by conditions prevailing in the United States. For many years the United States Standard Datum (later the North American Datum), based on the Clarke spheroid of 1866, has been the basis on which all geodetic triangulation has been calculated. The triangulation thus calculated is in turn the basis of maps and geographic positions in current use, many of the latter having a legal significance in connection with county, state or international boundaries. To recalculate the geographic positions of the 23,000 points that have been published and to redraw all current maps would obviously involve enormous labor and produce no little confusion and uncertainty, especially during the period of transition, and it is, therefore, the intention of the U. S. Coast and Geodetic Survey to continue to use the Clarke spheroid of 1866 (as part of the North American Datum) for all strictly geographical purposes.

In the scientific problem, however, of determining the figure of the earth, including local irregularities of shape with their important geophysical implications, much use is made of the deflections of the vertical, and it is obviously advantageous to have these deflections all over the world referred to the same ellipsoid. The question of recalculating the deflections of the vertical to refer them to the new international ellipsoid stands on an entirely different footing from that of recalculating geographic positions. In the United States there are less than 900 stations at which deflections of the vertical, either in the meridian or in the prime vertical or in both, are available, as compared with the 23,000 stations previously mentioned of which geographic positions have been published. The labor of making the change is obviously much less for the deflection stations alone than for all published stations. The confusion that would attend the change in the case of geographic positions in general should not exist in the case of the deflection stations, for the latter would be used only by

[2] This is the interpretation of the president and of the secretary of the section of geodesy, and in view of the way in which the vote on the international ellipsoid was taken, the two defining parameters being separately voted on at two different sessions, it is hard to see how any other interpretation could be tenable. In the tables for facilitating calculations on this new international ellipsoid, to be computed under the direction of the secretary, Colonel Perrier, the semi-minor axis will be taken as 6 356 911.946 meters.

[3] A meeting of the directors of nautical almanacs and ephemerides. (See Congrès international des éphémérides astronomiques tenu à l'Observatoire de Paris du 23 au 26 octobre, 1911. Published for the Bureau des Longitudes, Paris, 1911, pp. 36 and 42.)

specialists who would take care to find out the exact basis on which the deflections had been computed. For these reasons the U. S. Coast and Geodetic Survey hopes soon to undertake the task of referring deflections in the United States to the new international ellipsoid.[4]

The probable errors given by Hayford for the semi-major axis and the reciprocal of the flattening were, respectively, ± 18 meters and ± 0.5. Helmert[5] revised these figures by taking account of the uncertainty in the computed depth of isostatic compensation and thus increased the probable errors to ± 35 meters and ± 0.8. Helmert's figures represent the uncertainties as estimated solely by the residuals of the deflection stations in the United States and include no allowance for systematic errors such as possible constant errors in the standards of length used or errors due to reduction of bases to the geoid instead of to the spheroid. On this account Helmert's figures must be considered as still somewhat too small, judged merely by the data from which they were derived. On the other hand, there is confirmatory evidence of other sorts which tends to prove that Hayford's figures are perhaps more nearly correct than Helmert's computed probable errors would indicate. This is particularly true of the ellipticity, otherwise termed the flattening. From gravity observations Helmert[6] found 1/296.7 ± 0.4, Bowie[7] 1/297.4 ± 1.0 and Heiskanen[8] 1/296.7 ± 0.5. The precession of the equinoxes furnishes another means of deriving the flattening, if we grant the supposition that the density distribution within the earth is consistent with hydrostatic equilibrium, and since we know isostatic adjustment to be almost complete, this supposition seems unlikely to lead to serious error. Theoretically, in order to derive a flattening from the precession, we must assume not merely hydrostatic equilibrium in general but a definite law of variation from center to surface. The effect of changing the law is, however, surprisingly small, in fact, almost negligible. Any reasonably plausible law of density—and some not so plausible—will serve. Véronnet[9] derived from the precession a flattening of 1/297.12 ± 0.38. Here the ± 0.38 indicates, not probable error in the ordinary sense, but the estimated range of uncertainty due to our ignorance of the law of density, no allowance being made for the uncertainty of the observed value of the constant of precession nor of other quantities involved. De Sitter[10] after a careful discussion finds even narrower limits. His result is 1/296.92 ± 0.136. Most of this small probable error he finds to be due to the uncertainty in the mass of the moon, the uncertainty due to our ignorance of the law of density being but a comparatively small part, and the uncertainty due to the probable error in the precessional constant being negligible.

All these results are so close to 1/297 that we seem justified in estimating the actual uncertainty in this value of the reciprocal of the flattening as much less than Helmert's ± 0.8, or even than Hayford's original ± 0.5. That geodesists in general believe the flattening to be not far from 1/297 is shown by the practically unanimous vote of the section of geodesy at Madrid in favor of this value. There is, however, evidence from lunar observation and theory in favor of a larger flattening, about 1/294, and this can hardly be passed over in silence in a discussion of this sort. To present this matter at this particular point would, however, involve a long excursus, so a note dealing with this phase of the subject has been added at the end of this article.

The case for Hayford's semi-major axis is undoubtedly weaker than the case for his flattening. The comparative weakness is perhaps reflected in the vote of the section of geodesy, which was much less decisively in favor of Hayford's major axis that of his flattening.

The flattening can be derived by methods other than those involving triangulation (or traverse), but the semi-major axis can not.[11]

[4] This work is by no means so simple as might be supposed. The entire triangulation might be recalculated from the earliest stage on, but any of the known approximate short cuts may involve multiple values of the deflection at any given station, depending on the route by which the station is approached. See J. de Graaff Hunter, "The earth's axis and triangulation," Trigonometrical Survey of India, Professional Paper No. 16, 1918. Also W. D. Lambert, "Effect of variations in the assumed figure of the earth on the mapping of a large area," U. S. Coast and Geodetic Survey Special Publication No. 100.

[5] F. R. Helmert, "Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften," 1911, p. 19.

[6] F. R. Helmert, "Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften," 1915, p. 676.

[7] W. Bowie, "Investigations of gravity and isostasy," U. S. Coast and Geodetic Survey Spec. Pub. No. 40, 1917.

[8] W. Heiskanen, "Untersuchungen über Schwerkraft und Isostasie," Veröffentlichung des Finnischen Geodätischen Institutes, No. 4, 1924.

[9] A. Véronnet, "Journal des mathématiques pures et appliquées," Vol. 8 (1921), p. 416.

[10] W. De Sitter, "On the flattening and the constitution of the earth," Proceedings Koninklijke Akademie van Wetenschappen te Amsterdam, Vol. 27, 1924, p. 244.

[11] There is a method involving the observed values of the lunar parallax and of absolute gravity which may be made to give either the semi-major axis or the flattening, if the other is assumed to be known (see Helmert, "Höhere Geodäsie," Vol. II, p. 460; or De Sitter, "On the mean radius of the earth, the intensity of gravity

The data from the various pieces of triangulation scattered over the globe have not been comprehensively discussed to deduce the most probable value of the semi-major axis, and the writer in this connection can merely state his personal opinion that Hayford's determination of 6 378 388 meters, although larger than all preceding ones, is probably about correct, and that Helmert's probable error of ± 35 meters, although perhaps too small, is not very much too small. The writer would be somewhat surprised if a careful discussion of existing and future triangulation does not confirm Hayford's semi-major axis within 100 meters.

But the question of how closely the adopted ellipsoid of reference represents the actual geoid is by no means exhausted even when we have stated to our own satisfaction the probable errors of the parameters that determine the ellipsoid. It is also of interest to know how far the geoid and the ellipsoid may deviate from one another. To take an ideal case, let us suppose a perfectly ellipsoidal mass as large as the earth, its outer physical surface and the surfaces of equal density within being also equipotential surfaces. Then let us suppose that the outer crust down to a certain depth shrinks and swells here and there so as to form oceans, continents and mountains like the existing ones, but with perfect isostatic adjustment always maintained. The geoid, which formerly coincided with the outer surface, would go up with the continents and mountains and down with the ocean bottoms, but to a much less extent, the exact amount depending on the law of isostatic compensation. For existing areas of elevation and depression and a depth of compensation of 100 kilometers, the distance between the geoid and the ideal ellipsoid of closest fit (which need not be exactly our international ellipsoid[12]) would be 50 meters or less. If, however, isostatic compensation is imperfect to the extent of 10 or 15 per cent. of the total excess or deficiency of load, which is about the generally accepted estimate, and over wide areas, the 50 meters might be more than doubled. We should expect, however, these extreme figures of 100 or 150 meters to occur only very exceptionally, say in the Himalayan region or near the great ocean deeps.

Geoid contours were constructed by Hayford in connection with his earlier investigation[13] of his figures of the earth. Within the United States he found a variation in the elevation of the geoid above the Clarke spheroid[14] of 1866 amounting to 38 meters. This is somewhat greater than would be inferred from known differences of elevation and perfect isostasy with a depth of compensation of 100 kilometers but is by no means more than might be expected in view of ignorance of the real depth of compensation and the known imperfectness of isostatic adjustment.

There is a further possibility which might tend to increase the previous estimate of 100 or 150 meters for the extreme departure of the geoid from the ideal spheroid of reference. The longitude terms introduced by Helmert[15] and Heiskanen[15] into the formula for theoretical gravity, while not yet generally accepted, nevertheless should not be rejected out of hand as impossible. The amplitudes of these longitude terms are from six to nine times their probable errors, and the general improvement in the internal consistency of the gravity observations when these terms are included can be seen in other ways. Moreover, there is some slight evidence quite independent of the gravity data in favor of these terms.

Heiskanen's longitude term implies that a triaxial ellipsoid is a better approximation to the geoid than an ellipsoid of revolution; the longest equatorial radius is 172 meters greater than the mean, the shortest 172 meters less. This means a *systematic* departure of the geoid from the spheroid over a wide area to a maximum of 172 meters. Superposed on this systematic departure there would necessarily be local variations of considerable amount, so that the total departure of the geoid from the ellipsoid of revolution might considerably exceed 200 meters.

It should be noted, however, that the significance of these longitude terms, even if their existence and amount can be clearly established, is geophysical rather than geographical. There is no doubt that the

and the moon's parallax," Proceedings Koninklijke Akademie van Wetenschappen te Amsterdam, Vol. 17 1915, p. 1291). This method may be of some value for determining the flattening (see note at end of this article) but is in no way to be considered as comparable in accuracy with triangulation for determining the semi-major axis.

[12] When such an ellipsoid is actually used in connection with detached portions of triangulation, it is not really a single surface that is used, but many, all being ellipsoids of the same size and shape, to be sure, but not coincident in positions of their centers, nor even in the directions of their axes.

[13] "The figure of the earth and isostasy from measurements in the United States," U. S. Coast and Geodetic Survey, 1909.

[14] This is not, of course, the ideal spheroid of closest fit to the geoid as a whole, but it is conceivable that in the region of the United States it might fit the geoid even better than the ideal spheroid. Only differences in elevation of geoid above spheroid can be deduced from triangulation. The zero contour line must be taken arbitrarily.

[15] See references previously given, footnotes 6 and 8.

longitude terms would be important geophysically, for the existence of terms of that size would imply a widespread systematic departure from perfect isostasy of rather considerable amount, perhaps due to a tendency to over-compensation in oceanic areas.

On the other hand, it is doubtful whether geodesists will consider it desirable, unless these longitude terms should turn out to be much larger than now seems at all probable, to use a triaxial ellipsoid as a surface of reference rather than an ellipsoid of revolution. A triaxial spheroid involves considerable mathematical complication and does not abolish either the departure of the geoid from the surface of reference or the deflections of the vertical; it merely diminishes their average amounts. Unless these diminutions turn out to be very considerable, geodesists will probably continue to use an ellipsoid of revolution as the surface of reference.

It only remains to give the values of some of the geometrical and dynamical magnitudes inferable from the size and shape of the international ellipsoid of reference adopted on October 6 and 7, 1924, by the section of geodesy meeting at Madrid as part of the International Geodetic and Geophysical Union.

FUNDAMENTAL ELEMENTS OF THE INTERNATIONAL ELLIPSOID OF REFERENCE

a = semi-major axis (equatorial radius) = 6 378 388 meters

f = ellipticity (flattening) = $\frac{a-b}{a}$ = 1/297 = 0.003367 0034

Derived quantities

b = semi-minor axis (polar radius) = 6,356,911.946 meters

e^2 = square of eccentricity = $\frac{a^2-b^2}{a^2}$ = 0.006 722 6700

Length of quadrant of the equator	= 10,019,148.4 meters
Length of quadrant of the meridian	= 10,002,288.3 meters
Area of the ellipsoid	= 510 100 934 sq. km.
Volume of the ellipsoid	= 1 083 319 780 000 cu. km.
Radius of sphere having same area as ellipsoid	= 6 371 227.7 meters
Radius of sphere having same volume as ellipsoid	= 6 371 221.3 meters
M = mass ellipsoid[16]	5.988×10^{21} metric tonnes

Relation between geographic latitude, φ and geocentric latitude φ'.

$$\varphi - \varphi' = 695''.6635 \sin 2\varphi - 1''.1731 \sin 4\varphi + 0''.0026 \sin 6\varphi$$
$$= 695.6635 \sin 2\varphi' - 1.1731 \sin 4\varphi' + 0.0026 \sin 6\varphi'$$

Formula for theoretical gravity at the surface of ellipsoid (which is assumed to be an equipotential surface)

$$\gamma = \gamma_e (1 + 0.005288 \sin^2\varphi - 0.000006 \sin^2 2\varphi) \text{ cm/sec}^2$$

$$\gamma = \gamma_{45} (1 - 0.002637 \cos 2\varphi + 0.000006 \cos^2 2\varphi)$$

γ_e = gravity at equator at sea level =

978.038 cm/sec²	Bowie
978.052	Helmert
978.052	Heiskanen

γ_{45} = gravity in geographic latitude 45° at sea level =

980.621 /cm sec²	Bowie
980.629	Helmert
980.630	Heiskanen

Coefficient in the relation connecting the difference of equatorial and polar moments of Inertia, $C - A$, the Mass E and the equatorial radius a

$$C - A = 0.001092\, E\, a^2.$$

NOTE ON LUNAR METHODS OF DETERMINING THE FLATTENING OF THE EARTH[17]

There are two lunar methods of determining the flattening of the earth: the first a mixed geometrical and dynamical method dependent on the parallax of the moon and going back in principle to Newton's famous calculation that identified terrestrial gravitation with the force that retains the moon in its orbit; the second method purely dynamical and dependent on the lunar perturbations. This second method might be subdivided into several methods according to the particular perturbation used.

Newton calculated what the parallax of the moon would be if terrestrial gravitation, diminishing inversely as the square of the distance, were the controlling force, and on comparing this with the observed parallax he found them to agree within the uncertainties due to errors of observation.[18] The so-called observed parallax, however, that is, the equatorial horizontal parallax, really involves an assumption as to the ellipticity of the earth, and still other assumptions as to the local deflections of the vertical and as to the elevations of the geoid above the spheroid at the observatories where the parallax is determined. The usual and almost inevitable assumption hitherto has been that these deflections and elevations are all

[16] Mean density taken as 5.527, the value found by both Boys (Phil. Trans. A. Vol. 186 (1895) p. 1) and Braun, "Denkschriften der Akademie der Wissenschaften zu Wien," *Mathematisch-Naturwissenschaftlichen Classe*, 64, 1896, p. 187.

[17] Professor E. W. Brown gave valuable assistance in the preparation of this note. He is not, however, to be considered responsible either for the statements made or for the opinions expressed.

[18] There are terms involving also the mass of the moon and the effect of the sun which require no more than mention in this connection.

zero.[19] The calculation by which terrestrial gravitation is extended out to the moon and the parallax of the latter thus found is also affected by the assumed flattening of the earth, though not so much as the observed parallax. The flattening is found by assuming different values for it until the calculated equatorial horizontal parallax comes out equal to the observed parallax. This happens for a flattening equal to 1/293.4, according to De Sitter,[20] on the assumption that the deflections of the vertical at Greenwich and Cape of Good Hope observatories are zero. To make the two parallaxes equal for a flattening of 1/297 would require a deflection of about 11″ at both observatories. A calculation of these deflections on the theory of isostasy, with uniform compensation down to a depth of 120.9 km, gave deflections of 1″.16 at Greenwich and 3″.25 at the Cape. These had the proper signs to shift the reciprocal of the flattening from 293.4 towards 297 but are not large enough to change it all the way. They could be increased somewhat by adopting some other distribution of isostatic compensation, but the most probable explanation of much of the discrepancy in the flattening is observational error in the determination of the parallax. De Sitter concludes that the parallax calculated on the theory of gravitation is more reliable than the parallax directly observed and the parallax used in Brown's new lunar tables is likewise derived from theory. These conclusions of De Sitter and Brown and the uncertainty due to ignorance of the actual deflections of the vertical are thus unfavorable to the accuracy to the flattening obtained from it.

The purely dynamical lunar methods do not determine the flattening directly but instead the quantity $J = C - \frac{A+B}{2}$, where A, B and C are the principal moments of inertia of the earth in ascending order of magnitude, E is the mass of the earth and a its equatorial radius. This quantity J occurs in the developments in series of the earth's gravitational potential. If the earth were composed of homogeneous concentric spherical shells, J would eventually be zero. From J the flattening, f, is deduced by a simple formula.

$$\frac{}{E\,a^2}$$

The fact that the earth is not spherical, that is, that J is not zero, causes a number of perturbations in the moon's motion, both periodic and secular. From the observed values of these perturbations the value of J can be deduced and hence the flattening.

The *periodic* perturbations due to the figure[21] of the earth have been used to determine the flattening by various astronomers from Laplace down to the present. These periodic perturbations are, however, rather difficult to disentangle by observation from the perturbations due to other causes and hence the flattening deduced from them is not entitled to much weight.

The principal *secular* perturbations due to the earth's figure are those of the node and perigee of the lunar orbit. These, being cumulative with the lapse of time, can be determined very accurately. Unfortunately, however, for our present purpose much the larger part of these perturbations is due directly or indirectly to the action of the sun and thus must be determined and subtracted from the observed effect in order to determine the portion due to the figure of the earth.[22] There is also a portion, minute but by no means negligible in the present problem, due to the figure of the moon. Fortunately the portion due to the sun depends mainly on the ratio of the month to the year, a quantity known with great precision, so that apart from possible but not very probable errors in the theory of the smaller terms representing the sun's effect[23] and the uncertainty due to the figure of the moon, the perturbation due solely to the figure of the earth may be considered as having almost the same observational error as the entire observed secular perturbation, whether of perigee or node.

In connection with the preparation of new lunar tables the flattening was determined by Brown,[24] who found 1/293.5 from the combined results for the perigee and node. His adopted result 1/294.0 comes from including his value 1/294.4 determined from the

[19] The deflections and elevations are understood to refer to the unknown ideal ellipsoid that fits the earth as a whole as closely as possible.

[20] W. De Sitter, "On the mean radius of the earth, the intensity of gravity and the moon's parallax," Proceedings Koninklijke Akademie van Wetenschappen te Amsterdam, Vol. 17, 1915, p. 1294.

[21] The word *figure* is used in the extended sense of *figure and constitution*, more specifically its figure and constitution as they affect the value of J.

[22] Of the total annual motion of 146435″ in the perigee and 69679″ in the node all but about six or seven seconds of each are due to the action of the sun.

[23] The formulas for this occupy many lines of the quarto page of Delaunay's "Lunar Theory." Even so, they are not sufficiently accurate for the present purpose and the more modern theory, such as Brown's, does not use a complete and explicit formula, but is based on a process of numerical approximations. Delaunay's formulas, however, bring out the fact that the solar effect depends essentially on quantities known to a high degree of precision.

[24] E. W. Brown, Monthly Notices Royal Astronomical Society, Vol. 74 (1914), p. 563.

Greenwich–Cape of Good Hope parallax observations. By changing the assumed data for the figure of the moon De Sitter[25] found 1/296. The data for the figure of the moon depend partly on observation of the lunar librations, partly on assumptions as to the way in which the density of the moon varies from center to surface.

The process of deducing the flattening from lunar perturbations is thus seen to be far from simple. The possibilities for reconciling the flattening of 1/294 found by this method with the 1/297 of the international ellipsoid lie: (1) in changes in the secular variations deduced from observation; (2) in data for the figure of the moon; and (3) in possible corrections to a very complex mathematical theory.

Jones[26] has recently used occultations at the Cape of Good Hope to correct the motions of the perigee and node, and his corrections tend to diminish the disagreement between Brown's value of the flattening and the new international value. The older lunar observations, however, are not so well represented and it is questionable whether the full amount of his corrections can be accepted without further consideration.

The figure of the moon, as De Sitter has shown, gives one way of reconciling, partially at least, the two values of the flattening. Because the moon is smaller and cooler than the earth its figure might depart relatively more from hydrostatic equilibrium than the figure of the earth can, and there is evidence to show that it does. In the present state of our knowledge, or ignorance, a wide range of suppositions is admissible. In the absence of direct evidence on this point the disagreement between Brown's value of the flattening and the value obtained by other methods might be used as evidence to show what the figure of the moon actually is.

The theory of these secular variations, like the lunar theory in general, is exceedingly long and intricate, but it has been so much worked over that it is probably now correct and must be assumed to be so, at least until some one with the necessary ability, energy and inclination discusses the matter further and finds an error. There seems to be room, however, for some slight improvement in a much simpler theoretical matter, the calculation of the flattening, f, from J. Astronomers, as a rule, have omitted certain second order geodetic terms in the equation connecting these two quantities. The inclusion of these terms increases the reciprocal of the ellipticity by 0.4 or 0.5, or perhaps more, the exact amount depending on the exact form of the approximate equation between J and f, which may be stated in more than one way when correct to the first order only. These second order terms would thus help to diminish the discrepancy still further.

The only conclusion that can safely be drawn at the present time is that the discrepancy between the value of the flattening from lunar observations and the new international value is probably not quite so large as it first appeared to be, since various considerations all working in the same direction tend to bring the two values together. The ideal and the problem of astronomers and geodesists is, of course, complete reconciliation of the flattening as determined by geodetic methods with the values determined by all the various astronomic methods.

WALTER D. LAMBERT
U. S. COAST AND GEODETIC SURVEY

[25] W. De Sitter, Koninklikje Akademie van Wetenschappen te Amsterdam, Vol. 17 (1915), p. 1309.

[26] H. S. Jones, Monthly Notices Royal Astronomical Society, Vol. 85, 1924, p. 11.

CHARLES VANCOUVER PIPER

A BOTANIST of great ability, a man of unusual breadth, Charles Vancouver Piper, died on February 11, in his fifty-eighth year, and those who knew him well sustained a loss that can never be repaired. His work as botanist and agronomist is too well known in the United States and abroad to require comment on my part; it is of the man, not the scientist that I would say a personal word. Piper was built on big lines, mentally and physically. His mind worked directly and he was straightforward and fearless in his pursuit of truth and in working for what he believed to be the right course to follow. He believed in looking facts in the face impersonally and his free spirit could never understand why men should evade facts and beat about the bush. Piper's views were positive, but withal he was ever ready to listen to and to respect a dissenting voice. He never resented a difference of opinion on the part of a subordinate, but his logical mind was prompt to demand a reason for any view expressed. It was this willingness to entertain another view and the reasonableness of the man that endeared him to those whose privilege it was to work under his direction, while his broad knowledge and sound views won their respect. Contact with Piper was always stimulating; he was interested in all phases of life and he could suggest more problems in one interview than the average worker could tackle in a life time.

Piper gave himself freely to his work, worked with unusual rapidity, lost no time in arriving at decisions and consequently accomplished a prodigious amount in a short time. He read rapidly and would go over a manuscript so quickly that it seemed he could not have read it carefully, yet it was rare that a weak

argument or a loose expression escaped him. We shall not soon see the like of him again, but those of us who remain will have to content ourselves with having known him and we shall cherish the memory of one who was so well worth knowing.

A. J. PIETERS

SAMUEL MARX BARTON

DR. SAMUEL MARX BARTON died on January 5, 1926, in St. Luke's Hospital, Richmond, Virginia, after two years of declining health and about two months serious illness. Dr. Barton was born near Winchester, Virginia, May 9, 1859. He received his B.A. and Ph.D. degrees from the University of Virginia, and did his major work in mathematics. After leaving the University of Virginia in 1885, he taught at Emory and Henry College in Virginia until 1893 when he resigned to do two years of graduate study at Johns Hopkins University. At the end of these two years he taught a short time at Virginia Polytechnic Institute, and was called to the University of the South, where he taught from 1896–97 until the time of his death. His major work was in pure mathematics, but he taught some classes in civil engineering.

He is author of "An Elementary Treatise on the Theory of Equations" and "The Elements of Plane Surveying." He was a fellow of the American Association for the Advancement of Science and of the American Mathematical Society. He was one of the charter members of the Tennessee Academy of Science and served as treasurer, vice-president and president.

Dr. Barton was held in high esteem by his colleagues and students at the University of the South and his scholarship and culture won for him many friends.

JOSEPH K. ROBERTS

VANDERBILT UNIVERSITY

SCIENTIFIC EVENTS

THE SMITHSONIAN-CHRYSLER EXPEDITION TO AFRICA

THE Smithsonian Institution, in cooperation with Walter P. Chrysler, automobile manufacturer, of New York, will send a party of scientific men under the leadership of Dr. William M. Mann, superintendent of the National Zoological Park, to British East Africa early in March. Their object will be to bring back alive, for exhibition in the National Zoological Park at Washington, which is under the direction of the Smithsonian Institution, approximately one hundred species of wild animals never before seen in America, as well as many other African animals at present rare in this country and not now found at the national park.

The Smithsonian Institution sent out the big game hunting expedition to Africa under Theodore Roosevelt in 1909. During its eighty years of active scientific research, the institution has directed and participated in many expeditions for varied purposes, including the collection of specimens for mounting. But the trapping of wild animals alive in such quantity and variety as will be attempted by the Smithsonian-Chrysler expedition is believed to be without precedent.

Dr. William M. Mann, superintendent of the National Zoological Park, will lead the expedition. Dr. Mann announced that the immediate inspiration of the undertaking is the lack of either giraffes or rhinoceroses at the zoo. From that point the plans have expanded so that they not only include the collecting of many wild animals alive, but have given the expedition a very broad scientific scope.

Tanganyika Territory in British East Africa has been selected as the best place to trap the wild animals that are the object of the trip. The expedition will proceed inland from Dar-es-Salaam, and will form a camp, if possible, on a ranch not too remote from a railroad. That will be headquarters during the entire stay of five or six months in the field. An experienced animal keeper from the National Zoological Park will remain there in charge with a corps of natives, whom he will train to receive and care for the animals brought in, until arrangements can be made for shipping them to this country.

The personnel of the expedition will include Albert J. Loveridge, of the Museum of Comparative Zoology at Harvard University, who was for eight years assistant game warden in Tanganyika Territory; Stephen Haweis, naturalist, artist and author; F. G. Carnachan, amateur naturalist with wide field experience; Charles Charleton, photographer representing the Pathé News, who will make a complete record of the trip in motion pictures, which will be exhibited in a series of reels in this country, and Frank Lowe, keeper at the National Zoological Park, who has had eighteen years experience in the care of wild animals.

A FIELD COURSE IN GEOLOGY AT PRINCETON UNIVERSITY

A COURSE to be given on wheels will be offered by the department of geology of Princeton University next summer. Traveling about 10,000 miles in a Pullman car designed especially for the course, a party of twenty-two professors, instructors and undergraduates will make a study of the geology and natural resources of the United States.

Leaving Princeton July 1, the party will stop at localities of geological interest, where field trips will be made under the guidance of local experts. Lectures will be given en route and conferences will be

held after each field trip. Upon their return to Princeton about September 1, the undergraduates of the party will receive a final examination in the course.

Professor Richard M. Field, of the department of geology, will direct the trip and will be assisted by Professor A. F. Buddington. Associated with the project is a group of scientific and business men who form an advisory council. Among them are: Dr. John Grier Hibben, Professor William Berryman Scott, chairman of the department of geology at Princeton; William G. Besler, president of the Railroad Presidents of America; David White, chairman of the division of geology and geography of the National Research Council; E. F. Carry, president of the Pullman Company; Charles Campbell, deputy minister of mines for Canada; Ralph Budd, president of the Great Northern Railroad; Stephen T. Mather, director of the National Park Service; H. C. Bumpus, secretary of the American Museum's committee; A. D. Mead, vice-president of Brown University, and C. D. Walcott, president of the Smithsonian Institution.

The course will be open to American undergraduates who have had at least one year of college geology; to American and foreign graduate students, and to instructors or professors in geology.

The principal stops planned for the tour are the Silurian section at Niagara Falls, the Mesabi Copper Mines and Smelter at Anaconda, the Columbia River Basin and Lava Flows, Mt. Ranier, Crater Lake, Yosemite, Los Angeles Oil Fields, the Grand Canyon Flagstaff Volcanic Fields, the Petrified Forest, the Appalachian Coal Fields, the Appalachian Province and the Coastal Plain Province.

ENDOWMENT FOR THE HENRY PHIPPS INSTITUTE

ON February 20 announcement was made of the offer to the University of Pennsylvania on the part of Mr. and Mrs. Henry Phipps, of New York, to assist in the creation of an endowment for the Henry Phipps Institute for the study, treatment and prevention of tuberculosis. The board of trustees has formally accepted this offer. Mr. and Mrs. Phipps propose to give toward the endowment the sum of $500,000, on condition that the University of Pennsylvania raises an equal amount before January 1, 1927; on the fulfilment of this condition, there will also be deeded to the university all buildings and equipment belonging to the institute. Further provision has been made by the university authorities for the gradual accumulation of the funds allotted to the institute in its plan for raising the sum of $45,000,000, over a term of fifteen years. When this campaign is successfully completed, the Phipps Institute will have a total endowment of $2,300,000.

The Henry Phipps Institute was founded in 1903 by Mr. Henry Phipps, with Dr. Lawrence F. Flick, of Philadelphia, as medical director. In 1910, in order to provide continuity and permanence in development, the institute was placed under the care of the University of Pennsylvania under the general direction of a committee of the board of trustees. The funds to maintain the work were supplied by Mr. Phipps until 1919, and since that time have been provided partly by Mr. Phipps, and also by the University of Pennsylvania, the Carnegie Corporation and the Welfare Federation of Philadelphia. There has never been an endowment for the institute.

An important feature of the plan for the endowment is the provision that when the need for further study of tuberculosis is no longer pressing, either through the discovery of a cure or the effective control of the disease through other measures, the income of this endowment may be used for the study of other diseases.

The directors of the institute at present are Dr. Charles J. Hatfield, Dr. Eugene L. Opie and Dr. H. R. M. Landis.

REGIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY AT MADISON

A MEETING of mid-western sections of the American Chemical Society will be held at Madison, Wisconsin, from May 28 to 29, at which time the local section will be hosts to all those contributing to the publication of the *Chemical Bulletin*. Besides the member sections, which consist of the Milwaukee, Minnesota, Iowa, Ames, Louisville, Nebraska, Illinois, Purdue, Arkansas and St. Joseph Valley groups, there have been invited the Indianapolis, Iowa-Illinois, St. Louis and Omaha sections. While the meeting is essentially regional in that contacts will be made with chemists of some seven states, yet it will also assume something of a national scope in that the section of paint and varnish chemistry and the division of cellulose chemistry will each hold a meeting in Madison at that time also.

Arrangements for the meeting are in charge of the following members of the Wisconsin section, acting as chairmen of their respective committees: Farrington Daniels, executive; J. H. Mathews, program; Victor Lenher, finance; H. A. Schuette, publicity; A. W. Schorger, general entertainment; Miss Abby L. Marlatt, ladies' entertainment; H. N. Calderwood, Jr., registration; F. C. Krauskopf, excursions, and L. L. Withrow, guides.

Entertainment has been liberally provided for. It will take the form of a banquet with special features, group luncheons, auto rides to points of historical and local interest, personally conducted launch rides

on Lake Mendota and inspection of the chemical laboratories on the university's campus.

A program of scientific papers and general addresses, which will be opened by President Glenn Frank, of the University of Wisconsin, will be given, which, it is hoped, will bring to a focus the conspicuous lines of chemical investigation characteristic of that being carried on in the research centers of the middle west. Following the precedent set by the national society, visitors will be asked to be "paying guests," a registration fee of two dollars having been fixed to help defray the expenses of the meeting.

A SCIENTIFIC STUDY OF EDUCATIONAL WORK IN MISSISSIPPI

DURING the last three months of 1925, a survey of the entire public educational system of Mississippi was completed under the direction of Professor M. V. O'Shea, of the University of Wisconsin. It was found while the work was in progress that there were a number of educational and scientific problems that could not be solved without an extensive application of intelligence tests and measurements of educational achievement. Bernard B. Jones, of Washington, D. C., a former resident of Mississippi, who has contributed liberally to the support of higher education in the state, agreed to finance a comprehensive test and measurement program and appropriated a very generous sum for the work. The funds are being administered by Governor Whitfield. Professor O'Shea, who is directing the work, has the counsel of a board of consultants of twelve leaders in work in intelligence tests and educational measurements, in addition to Professor V. A. C. Henmon, Curtis Merriman and John G. Fowlkes, all of the University of Wisconsin, who are associated with Professor O'Shea in carrying through the program and scoring, tabulating and interpreting the results. Intelligence tests, measurements of achievement and tests for aptitudes will be applied to approximately 50,000 pupils in the elementary and high schools and the colleges and university, and in addition data relating to the hygiene and educational conditions of school buildings and the dietary regimen of pupils will be secured and correlated with intelligence and educational data. It is expected that a large amount of data of educational and scientific value will be secured from this thorough-going program, which is more extensive than has ever been carried through in any state heretofore.

SCIENTIFIC NOTES AND NEWS

A BUST of Dr. William H. Welch, director of the School of Hygiene and Public Health at the Johns Hopkins University, was unveiled on February 22 on the occasion of the commemoration day exercises of the university. Dr. Simon Flexner, director of the Rockefeller Institute, made the presentation speech.

PRESENTATION of the William H. Nichols Medal to Dr. S. C. Lind, associate director of the Fixed Nitrogen Research Laboratory, will take place at a meeting of the New York Section of the American Chemical Society at the Chemists Club on March 5. Dr. Colin G. Fink, of Columbia University, will speak on "My Friend, Lind," and Dr. Arthur B. Lamb, of Harvard University, on "Lind, the Chemist." Dr. S. C. Lind will deliver the address of acceptance on "Chemical Activation by Alpha Particles."

DR. K. F. HERZFELD, professor of theoretical physics and chemistry in the University of Munich, will arrive next month to fill an appointment as the first James Speyer visiting professor at the Johns Hopkins University. The professorship was recently established with an endowment of $50,000 given by James Speyer to provide for an exchange of knowledge between Germany and the United States by bringing a distinguished German scientist to this country each year.

ROY CHAPMAN ANDREWS, of the American Museum of Natural History, had conferred upon him an honorary degree by Brown University on February 24.

THE Robert W. Hunt medal was awarded to C. L. Kinney, Jr., metallurgist, of Chicago, at the annual meeting of the American Institute of Mining and Metallurgical Engineers, held in New York, for his paper on "The Economic Significance of Metalloids in Basic Pig Iron in Basic Open-hearth Practice." The J. E. Johnson, Jr., award was given to S. P. Kinney, metallurgist, U. S. Bureau of Mines Experiment Station, Pittsburgh, in recognition of his research work along blast-furnace lines.

THE Royal Danish Society of Science has awarded one of its annual gold medals for prize treatises to Harry Raymond and Ralph E. Wilson, both of the Dudley Observatory, Albany, for their observations in relation to the sun and certain stars.

LOYD A. JONES, physicist of the Eastman Kodak Co., has been awarded a prize of $250 by the Association of Scientific Apparatus Makers of America, for his paper on "Photographic Spectrophotometry." The prize was given for the best paper on scientific instruments presented during 1924 for publication in the instrument section of the *Journal* of the Optical Society of America and Review of Scientific Instruments.

DR. G. CLARIDGE DRUCE, of England, was elected a corresponding member of the Botanical Society of Geneva at the recent jubilee celebrations.

THE French government has conferred upon Sir Robert Hadfield the cross of the officer of the Legion of Honor in recognition of his contributions to metallurgy.

THE Académie de Médecine of Paris has awarded the Buisson prize of 12,000 francs to Dr. Levaditi for his work on bismuth in the treatment of syphilis.

PROFESSOR H. BRERETON BAKER has been nominated to the office of president of the Chemical Society of England, in place of Dr. Arthur W. Crossley, who has resigned on account of ill health. The annual general meeting of the society will be held at the University of Manchester on March 25.

THE retirement of Professor Carl H. Barus, who has been professor of physics and dean of the graduate department of Brown University for twenty-three years, is announced. Professor Rowland G. D. Richardson, head of the department of mathematics, will succeed Professor Barus.

OWING to his absence from the United States for a period of several months, Dr. C. H. Myers has resigned the executive secretaryship of the section for agronomy of the International Congress of Plant Sciences. Dr. R. G. Wiggans, of the department of plant breeding, Cornell University, has been appointed to fill the vacancy.

THEODORE J. BRADLEY, dean of the Massachusetts College of Pharmacy, Boston, has been elected president of the American Pharmaceutical Association for 1926–27.

DR. ADA POTTER, until recently first assistant in the clinic and laboratories of Dr. Cornelius Winkler in the University of Utrecht, Holland, has been appointed for a term of two years as associate in the research program in cerebral physiology of the State University of Iowa, with the title of research associate professor of psychiatry.

AN exchange professorship has been arranged between Dr. J. G. Thomson, director of protozoology in the London School of Hygiene and Tropical Medicine, and Dr. R. W. Hegner, professor of protozoology in the School of Hygiene and Public Health of the Johns Hopkins University. Dr. Hegner will sail on March 31 to take up his duties in London.

DR. MAX ELLIS, professor of physiology at the University of Missouri, has been granted a year's leave of absence to do research work abroad.

DR. FREDERICK L. HOFFMAN, consulting statistician, Prudential Insurance Company of America, is making arrangements for an extended trip to Mexico and Guatemala during the coming summer. Dr. Hoffman will be chiefly concerned with Mexican mortality problems, but will also give attention to the physical anthropology of different Indian tribes and the effects of tropical conditions on the duration of life among Europeans and white settlers from North America.

DR. L. H. DEWEY, chief of the office of fiber investigations, U. S. Bureau of Plant Industry, has gone to Porto Rico for two months of field work.

DR. ALICE M. OTTLEY, ssociate professor of botany at Wellesley College, has returned from South Africa where she has been exchange professor of botany at the University of Witwatersrand in Johannesburg. In addition to her teaching, Dr. Ottley collected plants in several regions of very different climatic and soil conditions, centering her work in the Union of South Africa and in the regions around Cape Town.

DR. ALMA J. NEILL, associate professor of physiology at the University of Oklahoma, has been awarded a scholarship by the American Association of University Women, and will spend the next academic year, on leave from the university, in work abroad.

RECENT visitors to the United States include: Sir George Buchanan, senior medical officer of the Ministry of Health, London; H. Bennett Johnson, of the Welcome Tropical Research Laboratory, Khartum, Sudan; J. G. Meyers, entomologist, Wellington, New Zealand; Kota Monzen, of the Imperial College of Agriculture and Forestry, Morioka, Japan, and Dr. V. V. Nikolsky, chief of the entomological section, Moscow Tropical Institute, Moscow, Russia.

PROFESSOR PAUL SABATIER, director of the Institute of Chemistry at the University of Toulouse, France, will visit the United States next September.

DR. CUTHBERT CHRISTY has left Nyasaland for London with 5,000 specimens of fish, including many new species, from Lake Nyasa, the result of a ten months' fishing expedition on behalf of the British Museum.

DR. HENRIK LUNDEGARDH, director of the Ecological Station at Torekov, Sweden, recently gave at the U. S. Department of Agriculture an illustrated account of investigations in plant ecology conducted on the island where his station is located.

DR. J. BARCROFT, professor of physiology at the University of Cambridge, delivered a lecture entitled "Hæmoglobin," before the Chemical Society, of England, on February 11, in the Chemical Laboratory at University College, London.

A SERIES of three lectures under the auspices of the Bartol Research Foundation will be given by Dr. E. O. Hulburt, of the Naval Research Laboratory,

Washington, D. C., in the Lecture Hall of the Franklin Institute, at four p. m., as follows: March 9, "The Kennelly-Heaviside Layer and Radio Wave Propagation"; March 12, "Hydrogen Spectrum Lines in the Stars and in the Laboratory"; and on March 17, "The Pressure of Light on Electrons."

PROFESSOR GEORGE G. SCOTT, of the Biology Department of the College of the City of New York, lectured before the Williams College Faculty Science Club, at Williamstown, Mass., on February 19, on "A Biological Interpretation of Human Society."

ON February 13, Dr. Barnum Brown, of the American Museum of Natural History, delivered an address to the Royal Canadian Institute on the subject "A Journey through India and Kashmir."

TWO peaks of the Sierra Nevada Mountains in California hitherto unnamed have been given the titles of Mount Irvine and Mount Mallory, in honor of the two members of the British expedition for the conquest of Mount Everest, who perished near its summit in 1924.

PROFESSOR ARTHUR ROBERTSON CUSHNY, of the chair of materia medica and pharmacology in Edinburgh University since 1918, died on February 25, aged sixty years.

DR. H. KAMERLINGH ONNES, emeritus professor and director of the physical laboratory at the University of Leyden, died on February 21, aged seventy-six years. He received the Nobel prize for physics in 1913.

PROFESSOR GUNNAR SCHOTTE, director of the Swedish State Forest Experiment Station at Stockholm, recently died at the age of fifty-one years.

THE United States Civil Service Commission announces an open competitive examination for archeologist, receipt of applications for which will close on April 6. The examination is to fill a vacancy in the Bureau of American Ethnology, Smithsonian Institution, and vacancies occurring in positions requiring similar qualifications, at an entrance salary of $3,800 a year. The duties are to study various phases of prehistoric life of Indians and Hawaiians by archeological field work, and to write reports and bulletins on this field work for publication with a view to the advancement and diffusion of knowledge relating to the American Indians.

AT a meeting of the Northeastern section of the American Chemical Society to be held at the Massachusetts Institute of Technology on March 12, Dr. Benjamin T. Brooks, consulting chemist on the staff of Arthur D. Little, Inc., will speak on "The Relation of Research to the Petroleum Industry," and Professor Frederick G. Keyes, head of the department of chemistry in the Massachusetts Institute of Technology, will read a paper on "The Importance to Chemical Theory of a Knowledge of the Physical Properties of Substances."

THE Ohio Phytopathological Society held its annual winter meeting at the Ohio State University on February 4. At the afternoon meeting papers were given by Curtis May, A. G. Newhall, J. W. Baringer, S. S. Humphrey, W. G. Stover and E. G. Hambleton, R. C. Thomas, R. B. Wilcox, Paul E. Tilford, H. A. Runnels, W. G. Stover and H. A. Runnels and H. C. Young. Two papers were on the treatment of cereals for the control of smut, two on mosaic, two on tomato streak, two on Fusarium, one on Appressoria of *Colletotrichum lagenarium*, one on chemical structure of fungal walls and one on the progress of barberry eradication. The business meeting was held after the banquet following the afternoon program. The following officers were elected for the coming year: *President*, Dr. W. G. Stover, Ohio State University; *secretary-treasurer*, S. S. Humphrey, Ohio State University; *member executive committee*, D. H. C. Young, Ohio Agricultural Experiment Station.

THE bill to prohibit teaching in tax-supported schools the theory that man "ascended or descended from lower animals" was passed by the Mississippi Senate on February 24, 29 to 16, after three hours debate. The bill was passed by the House of Representatives on February 8 by a vote of 76 to 32.

THE Stanley P. Black Memorial Fund is endeavoring to provide for a lecture on medical and allied subjects two or three times a year by scientists of national reputation. The lectures will be similar in scope to the Lane lectures at the Stanford University Medical School. The Stanley P. Black Memorial Hall in the Professional Building, Pasadena, will be completed March 1, and Dr. Alfred S. Warthin, professor of pathology, University of Michigan Medical School, will inaugurate the series of lectures in March or April.

THE will of the late Dr. Henry Crain Tinkham, dean of the University of Vermont College of Medicine, Burlington, provides for establishing one or more scholarships in the college to be known as the Dr. H. C. Tinkham scholarships; Dr. Tinkham also gave his medical library to the college, and his surgical instruments to the Mary Fletcher Hospital.

THE Museum of the American Indian, Heye Foundation, has filed plans for a three-story brick museum and storehouse, to occupy a plot 60 by 100 feet, on the west side of Eastern Boulevard in the Bronx, New York City. The building will cost $100,000. The ground is a part of a six-acre triangular plot presented to the museum by Archer M. Huntington.

DR. WILLARD ROUSE JILLSON, director and state geologist of the Kentucky Geological Survey, Frankfort, Ky., recently gave his private geological collection consisting of mineral ores, rocks and fossil specimens to the University of Louisville, Louisville, Kentucky. The collection consists of several hundred specimens.

SIX hundred specimens of rocks from the Hawaiian Islands, collected by Sydney Powers, chief geologist of the Amerada Petroleum corporation, Tulsa, have been contributed to the department of geology at the University of Oklahoma.

UNDER the auspices of the Commission of Standardization of Biological Stains a *Journal of Stain Technology* has just been started under the editorship of H. J. Conn, chairman of the commission, who represents the field of bacteriology. The fields of chemistry, zoology, pathology and botany are represented, respectively, by the following associate editors: W. C. Holmes, S. I. Kornhauser, F. B. Mallory and W. R. Taylor. The journal is devoted primarily to the nature and uses of biological stains, also including articles dealing with microscopic technic in general when they have a close bearing on staining procedures. Brief notes of only one or two paragraphs dealing with new staining procedures are welcome. This journal is called to the attention of those who have matter for publication along the lines indicated. Authors are invited to submit the manuscript to the editor at the address: Lock Box 299, Geneva, New York.

ACCORDING to *Museum News,* an exposition of new discoveries in science was opened at the Carnegie Museum, Pittsburgh, on January 9, the exhibit being patterned somewhat after the demonstration made each year at the president's reception of the British Royal Society in London, which the director of the museum, Douglas Stewart, attended last summer. In developing plans for the exposition the Carnegie Museum has secured the cooperation of the Engineers Society of Western Pennsylvania, the Pittsburgh Section of the American Chemical Society, the Federal Bureau of Mines, the Mellon Institute of Industrial Research of the University of Pittsburgh and the Carnegie Institute of Technology. Each of these organizations has recently developed products on exhibition. In addition all the large industrial concerns of the district have offered their assistance in working out the displays. The uses of the various exhibits, inventions and products were explained and demonstrated to visitors to the museum.

ACCORDING to the *Electrical Review* a new institution has been formed, to deal in a scientific manner with the problem of preparing and utilizing our fuel resources with much greater efficiency. This new organization, which is called "The Institution of Fuel Economy Engineers," was inaugurated at a meeting of experts held recently at the Engineers' Club, London. Among those taking part in the proceedings were Dr. T. Barratt, Professor Bacon, Mr. W. C. Goodchild (representing Sir Henry Fowler), Dr. R. Lessing, Messrs. E. W. L. Nicol, John Bruce, S. W. Bettony, J. S. Gander and A. C. Mahar. The first council was elected and it was decided to form sections in different parts of the country. It is hoped to make this new institution the responsible organization representing every section of fuel technology throughout the country.

SINCE January 1, 1926, the secretarial office and the office of the *Journal of the American Pharmaceutical Association* have been located at 10 West Chase Street, Baltimore. All mail for the American Pharmaceutical Association and for the Journal of the association should be sent to this address. Combination of the offices of the association, which have heretofore been located in different cities, is a preparation for the greater service to be promoted by the American Pharmaceutical Association when the new headquarters building, for which a campaign has been in progress, will be procured. The location of the proposed new building has not yet been decided on.

THE Leningrad Institute of Applied Botany is organizing a series of expeditions to the tropical countries for the purpose of importing the seeds of cereal plants which do not exist in USSR, but can be successfully cultivated. Professor Vavilov, director of the Department of Field Cultures, will proceed to the Mediterranean Archipelago, Egypt, Abyssinia, Syria and Palestine to investigate the cultures of barley, beans, flax, etc. Last year Professor Vavilov imported about 7,000 samples of seeds from Afghanistan. Professor Burasov is at present studying the cultures of potatoes, tomatoes, maize, sunflower, etc., in the Western Andes of South America. Professor Voronov is at work in the Brazilian mountains, studying the types of rubber trees that can stand a severe climate.

ONE of the finest country estates in the vicinity of Boston has been presented to the New England Federation of Bird Clubs as a gift to be maintained in perpetuity as a sanctuary for birds and other species of wild life. The donors are Gorham Brooks, of Boston and Medford; Mrs. Robert W. Emmons, 2d, of Boston and Bourne, and Mrs. James Jackson, of Boston and Westwood. The estate consists of a large brick mansion house, a brick stable, one large cottage and more than eighty-four acres of land of the finest kind of rolling territory, forested in spots, studded with spring-fed ponds and possessing large fertile fields for such cultivation as may be required in con-

nection with its proper management in the future for wild life conservation.

ACCORDING to an associated press dispatch, a refund of taxes to the Nobel Foundation which would greatly increase the value of the Nobel prizes for next year has been recommended to the Riksdag by the minister of finance, who admits that the taxes so far automatically imposed on the Nobel estate have been out of proportion to the burden laid on the rest of the country. The government proposes to refund three fourths of the sums paid by the estate for 1926, and asks the Riksdag for a special appropriation for that purpose.

UNIVERSITY AND EDUCATIONAL NOTES

THE University of Pennsylvania has received the sum of $100,000 as a memorial to former Provost Charles C. Harrison, a gift from his sons and daughters. The fund is to be used for an endowment to establish visiting lectureships at the university.

THE late John D. Larkin has bequeathed to the University of Buffalo the sum of $100,000, which is to be added to the John D. and Frances H. Larkin Foundation, toward which Mr. Larkin has previously given $250,000. The fund is primarily for the endowment of the school of chemistry.

TWO $100,000 gifts have been received by the Johns Hopkins half century committee, making a total of $1,358,283 collected. It is hoped to raise in Maryland $1,500,000. Mr. and Mrs. Henry Walters are the donors of the first $100,000, and Mr. R. Brent Keyser, president of the board of trustees of the university, of the second $100,000.

VASSAR COLLEGE has received a gift of $75,000 by an anonymous friend for the erection of a demonstration laboratory in connection with the course in eugenics recently established at the college. The laboratory will serve for the scientific study and demonstration of the care and nurture of children from infant years to school age. It is expected that the building will be erected on the Wing Farm, land recently acquired by the college.

MRS. FRANK R. LILLIE has made an additional gift of $4,000 to the University of Chicago toward the construction and equipment of the Whitman laboratory of experimental zoology, making a total of $94,000 given by Professor and Mrs. Lillie for the laboratory.

DR. JAMES NATHANIEL JENNE, professor of clinical medicine and therapeutics in the College of Medicine of the University of Vermont, has been elected acting dean of the college. Dr. Jenne succeeds the late Dr. H. C. Tinkham, whose death occurred last December.

DR. CHARLES H. KEENE, professor of hygiene and director of physical education at the University of Buffalo, has been appointed lecturer in physical education at the Graduate School of Education, Harvard University, and also director of the Harvard summer school of physical education.

PROFESSOR H. W. TAYLOR, formerly professor of mathematics at Emporia College, has been appointed professor of mathematics at Southwestern College.

AT the University of Aberdeen, Dr. John Cruickshank, reader in bacteriology, has been appointed to the new chair of bacteriology, and Dr. A. W. Borthwick, chief research officer and education officer to the forestry commission, has been appointed to the new chair of forestry.

DISCUSSION AND CORRESPONDENCE

BLEACHED FLOUR AND NEUTRALIZED CREAM

IN justice to the milling industry as well as to the bread-eating public, I feel that some statements in Dr. H. W. Wiley's two recent book reviews in SCIENCE of October 16, 1925, p. 352, and December 4, 1925, p. 511, in which he takes occasion to attack what he calls "corpse-white" flour, should have some comment. The present writer is not an apologist for flour bleaching, indeed, he has frequently been accused of being an active opponent of all kinds of bleaching, but in fairness to the readers of SCIENCE, not all of whom may consider themselves expert in the subject of nutrition, the demand of some part of the public for a pure white, bleached flour should be considered, as also the demand for a flour not containing the bran.

I am glad to note that Dr. Wiley is willing to allow the importance of bread by calling it our "fundamental diet"—a statement that admits considerably more than the statement of one who said it had "little more food value than plaster of Paris." I am also glad to note his admission of the greater digestibility of the protein and starch in standard patent flour as compared with graham flour, though he follows it up by a quotation which, as an offset, aims to magnify the importance of the mineral and vitamine content of graham flour.

It is difficult for one who has interested himself in the methods and details of milling and the efforts of millers to produce from wheat the maximum amount of pure flour to have sympathy with his criticisms directed against wheat conditioning methods in which the purpose of the miller is to produce as sharp a separation between the branny and the floury portion of the wheat grain as is possible. Once having learned the effect which water has in preventing the comminution of the bran, it would

be strange indeed if the miller did not endeavor to practice using the optimum amount of water for this purpose. As a matter of fact, the amount of water that may be used in conditioning is very closely limited. Too little added moisture means either a low flour yield or a yield of flour containing considerable speckiness or grayness. On the other hand, too much added water causes a considerable reduction in flour yield due to gumming up, flaking, reduction of bolting surface, and production of flours and feeds which are very subject to molding, souring, or other damage directly due to excessive moisture content.

American flours are notable for their low moisture content and consequent ability to keep in good sound condition for many months. English and French flour will average at least 2 per cent. more moisture and they must be consumed without delay. American flours exported to Europe, including both the high grade flours and the low grade flours, are also notable for their excellent keeping quality even after the long ocean voyage.

It is indeed a matter in which American millers take pride "that the flour of the country is gradually approaching the condition in which the bran and germ remnants are reduced to the greatest possible minimum," but it does not follow "that this means a more thorough extraction from the white flour of the vital elements of the wheat" or that "it is distinctly deteriorated in nutritional value." What is "nutritional value?" It is not claimed that white flour as purchased from the grocer is a perfect food. No one eats white flour. It is used in the manufacture of numerous articles of food which are eaten together with other foods. What does it signify if fowls or white rats fed nothing but white flour die after a few months? The same thing will occur with almost any single food including even milk which comes pretty near being a perfect food for infants. Even a liberal diet of graham bread would not supply sufficient iron or iodin nor even the important element calcium, since so large a proportion of the relatively limited amount of minerals in the branny portion of the wheat is indigestible in the human stomach. The mineral elements present in wheat and bran and flour are those of which there is little or no lack, *viz.*, phosphorus and potassium, wheat ash being about three quarters potassium phosphate. Feed the bran to cows, equipped by nature with digestive fluids containing enzymes capable of breaking down the cell walls of bran, alfalfa and other coarse fodders and let them supply us the necessary calcium, vitamines, etc. Then make from milk, flour and yeast a good, rich milk bread which, with other ordinary foods, will contain most of the needed elements. A full milk loaf spread with vitamine-rich butter comes much closer than any single article of diet to supplying the nutritional value desired.

Dr. Wiley doubts if any household consumer ever demanded a whiter flour. His doubts may be set at rest. During twenty-five years' experience in constant consultation with millers and flour buyers, no small proportion of our investigations have been concerned with the question of color. Any small miller dealing directly with housewives of the town could testify on this point.

Dr. Wiley appears to hold the common notion that the darker portions of flour produced in milling can be bleached and sold at the price of patent flour. But no bleaching process is capable of removing or bleaching the branny impurities which give a grayish or dull color to flour. Flour bleaching processes do only what bleaching does to linen—remove yellowness, therefore grayness remains just as gray as before.

I was unaware until Dr. Wiley stated it that nitrogen peroxid is a mixture of nitrogen and nitrous oxids or that nitrous oxid has any flour bleaching ability. Whether the presence in flour of 0.2 to 0.5 parts per million of nitrogen in nitrites or of 24 to 159 parts of chlorin in chlorids or the residue of 32 parts of benzoyl peroxid or rather, of what remains of these substances after fermentation and baking into bread, is deleterious, is a question regarding which the Department of Agriculture and the general public seem long ago to have come to the same conclusion which Dr. Bailey expressed, namely "that the effect of bleaching on digestibility is too slight to merit consideration."

Dr. Wiley says: "The curse of corpse-white flour will, of course, die out in time. The people of our country are learning little by little that the whiteness in the flour is inversely proportional to its nutritive value." This prophecy is not justified by any facts which I know of. The proportion of bleached flours to unbleached flours which we have seen in recent years is certainly increasing. I have no figures for the proportional output of bolted flour in comparison with grahams and so-called whole-wheat flours. Any miller is willing to supply graham and whole-wheat flours, but he knows from experience that these flours soon become rancid and unsound while the high grades of flour remain sound and wholesome months after the low grade flours have become inedible. I infer that it is both bleached and unbleached flours upon which Dr. Wiley considers a curse rests. To all appearances, however, the general public is continuing in its belief (justified both by the bacteriological count and the microscopic examination) that whiteness or creamy whiteness is a sign of cleanness, and that bread is one of the cheapest and best foods. Let those who need a mild laxative or

who are over-nourished or who want an occasional change from light bread, eat bran or graham bread, but let men of science not accept at face value all the claims of "braniatics" and certain not disinterested food manufacturers.

CHARLES H. BRIGGS
THE HOWARD WHEAT AND FLOUR TESTING LABORATORY,
MINNEAPOLIS, MINN.

IN the issue of SCIENCE for October 16 Dr. Wiley reviews a recent book by Sherman. In the course of this review Dr. Wiley takes occasion to digress from his subject to mention some things concerning butter which he states Sherman failed to mention in the book reviewed.

Dr. Wiley's statements are unjust to the dairy industry because they are inaccurate. The three statements to which I take exception are: (1) That the standard for butterfat has been reduced 4 per cent. in 20 years. (2) That 75 per cent. of the creameries neutralize the cream used for butter manufacture. (3) That the purpose of neutralizing is to make possible the use of cream otherwise unfit for butter manufacture.

His basis for stating the standard for butterfat has been reduced 4 per cent. in comparing the analyses of butter made for exhibition purposes 25 years ago when there was no legal standard with the legal standard at present, not the composition of butter as found on the market at present. It is a well-known fact that butter made for exhibition purposes has a somewhat higher fat content than the regular market product due mainly to lower salt percentage. For this reason the low water content of butter reported in 1902, which was based upon analyses of exhibition samples, was unquestionably not typical of the regular market product at that time. Analyses of 170 market samples reported in 1907 showed an average fat percentage of 82.35. Analyses by this division of 2,051 exhibition samples in 1923 showed an average of 83.46 per cent. of fat. At the same time 363 market samples averaged 82.35, or exactly the same as found in 1907. A total of 1,000 analyses of market butter in 1925 showed 81.31 per cent. fat. The most that can be said is that American market butter now averages about one per cent. less fat than in 1907 and closely approaches the composition of the competing product of other leading butter producing countries.

The statement that 75 per cent. of the creameries neutralize the cream before churning is based upon inaccurate information. As a matter of fact no statistics are available on this point and the basis of any statement made must be familiarity with conditions based upon a close contact with the industry.

Nearly one fifth of the creamery butter manufactured in the United States is made in Minnesota and this state stands far in the lead in this product. A close knowledge of conditions in this state makes possible the statement that out of about 840 creameries in the state a total of less than fifty neutralize the cream used. One fourth of all the creameries in Minnesota are making butter from pasteurized sweet cream, that is, fresh cream in which no fermentation of any kind has developed to any appreciable extent. The other creameries develop some acid fermentation in the cream as has been done for centuries. A considerable number of this group use pure culture starters as an aid in securing the desired fermentation.

While we do not commend the practice followed by some creameries of reducing the acidity of the cream by the use of lime, the so-called neutralization, we deny the implication that cream so treated is injurious to health or that it is otherwise unfit for butter manufacture. The cream which is neutralized has undergone ordinary acid fermentation with some development of yeast after a relatively high acidity is reached. It is well known that these types of fermentation are not ordinarily accompanied by injurious products and not the slightest evidence has ever been presented that cream of this kind is in any way detrimental to human health. The writer has used dried buttermilk from such cream as a sole feed for young calves without the least evidence of trouble, in fact less sickness was experienced than usual when ordinary skim milk is used. Large quantities of the same product are used as a food for chicks with excellent results.

The purposes of neutralizing cream are two-fold, the first is to prevent excessive loss of fat in the buttermilk, the other is to increase the keeping quality of the butter. It has been known for several years that free acid in butter regardless of origin has an unfavorable effect upon the keeping quality. The quality of the fresh butter is not appreciably improved as a result of neutralization of the cream from which it is made.

C. H. ECKLES
CHIEF OF THE DIVISION OF DAIRY HUSBANDRY,
UNIVERSITY OF MINNESOTA

I APPRECIATE the opportunity the editor of SCIENCE gives me to reply to Dr. Briggs and Dr. Eckles.

Dr. Briggs, I think, has presented the case in favor of white and bleached flour most admirably. As he says, it is difficult for one who has interested himself in the methods and details of milling to have sympathy with my statement that adding water to wheat is an adulteration. I may say that it is difficult for

one who has spent almost his whole active life in protecting the interests of the consumer against unwarranted practices by the manufacturer and dealer to have sympathy with the adulterators of flour from any point of view. Such adulterations add to the miller's profit without adding anything to the nutritive value of the flour. Bleached flour has been pronounced by the courts both adulterated and misbranded and has therefore no right to enter interstate commerce nor to be sold in the District of Columbia. In closing this discussion, I am content to submit the question to the readers of SCIENCE, a group of citizens well qualified to judge without prejudice. At the same time, I must admit that the dietitians of the country look with a very considerable degree of disfavor upon diminishing the nutritive value of flour in order to secure the greatest yield and the least nutritious product. Dr. Briggs asks: "What is nutritive value?" I answer, that nutritive value is to secure the largest amount of nutriment that nature has put in our foods. The millers are endeavoring to produce a food with a minimum content of nutritive value. Graham bread may not supply a sufficient amount of iron or iodine, but it does supply a sufficient amount of phosphorus and high grade proteins to give the maximum nutritive value to ground wheat. This is not denied in any place by Dr. Briggs. It is, of course, possible to supply some of the vitamins and minerals removed in the milling, by others existing in other kinds of foods. Is it reasonbale, however, to increase the demand for such foods as do supply these missing elements, when they could all be secured by eating our wheat in a form as nearly as possible to its natural composition? Not only does it cost a lot more money to make white flour a nutritious food, as Dr. Briggs admits, but it is a useless expenditure when we have to buy from other sources the very elements which the millers take out of the grain.

I take it that no better exposition of the merits of white and bleached flour can be presented than has been done by Dr. Briggs. I hope, however, that many other writers on health can give a better exposition of the merits of whole wheat flour than I have endeavored to give in the review of the books in question. I am quite content to leave the matter now to the judgment of the intelligent people of this country, and that includes all the readers of SCIENCE. I feel that the theories which I have endeavored to present are those which will commend themselves more and more to the sober judgment of the American people in general.

Dr. Eckles claims that there are three errors in my review of Sherman's book on the subject of butter. The first error is that the butter fat standard has been reduced by 4% in the last few years. He admits that the best butter made for exhibition purposes had a percentage of butter fat 4% higher than the standard at the present time. He also points out that 2,051 exhibition samples of butter in 1923 showed an average of 83.46% of fat, almost 4% above the present standard. His own statements, therefore, sustain my point.

The second error is that 75% of the creameries neutralized the cream before churning. My authority for this statement is found in the hearing before the Commissioner of Internal Revenue in a remark made by the attorney of the so-called neutralizers.

The third error pointed out by Dr. Eckles was that the purpose of neutralizing butter was to make it possible to use cream otherwise unfit for butter manufacture. I know by personal observation and study that this statement is positively correct. The authorities enforcing the food and dairy laws of Minnesota, the state in which Dr. Eckles resides, agreed with me in my statements respecting the butter made from neutralized cream. Dr. Eckles does not, therefore, represent the official opinion of Minnesota on this question.

All the butter made in creameries of neutralized cream enters interstate commerce with no statement of the origin or character. The people who buy creamery butter suppose they are getting the highest type of butter and they do not know until they eat it, or try to eat it, that some of it is the lowest type of butter.

The final solution of this problem is quite similar to that of white and bleached flour. Shall the manufacturers be protected in selling a depreciated article for the price which they get for the real genuine article? There is a tendency in some quarters of official life to protect the manufacturer while, under the food laws which Congress enacted, the first duty of the officials is to protect the consumer.

H. W. WILEY

SCIENCE NOT IN IT

ON January 1, 1926, the *Washington Post* published a symposium on "The Helpful Achievements of 1925" composed of replies of a number of national and local business, professional and political leaders, to the question "What in your opinion has been the most helpful and outstanding development of the year 1925?"

It is worthy of consideration that no one of the fifty-eight distinguished men cited any scientific discovery among the achievements of the past year.

EDWIN E. SLOSSON
DIRECTOR, SCIENCE SERVICE,
WASHINGTON, D. C.

LETTER TO THE EDITOR OF SCIENCE FROM THE PRINCIPAL SCIENTIFIC AUTHORITY OF THE FUNDAMENTALISTS

ON returning from Switzerland to my headquarters England, I find your brief letter of January 6. You say that you do not "have clearly in mind the cumstances" to which I have referred in my previ- letter. I suppose that if you had thought the tter of sufficient importance you could have con- lted your letter files of last year and the year be- re and those of some two years before that.

After the shameful way in which you have treated e, it is certainly very appropriate for you to say w that the "tone" of my letter "apparently makes advisable further consideration of the subject."

May I repeat that Professor Schuchert's letter is clear libel, and that both he and you are due for me legal demands whenever I return to America om the rather extended trip around the world on hich I have entered. An apology and retraction w would do no good; I am through with this sort f foolery. I will see what the law can do for me. pparently there is only one kind of argument that ch men as you and Schuchert can understand; and intend that you shall have it.

GEORGE MCCREADY PRICE

SCIENTIFIC BOOKS

The Natural History of Crystals. By A. E. HUTTON. E. P. Dutton & Co., 1924. 274 pp.

The Structure of Crystals. By R. W. G. WYCKOFF. The Chemical Catalogue Co., 1924. 454 pp.

X-rays and Crystal Structure. By W. H. and W. L. BRAGG. Harcourt, Brace & Co., 1924. 4th edition, 313 pp.

THESE three books on crystal structure may well be used to illustrate the truism that no two writers can handle the same subject in the same way; each one sees the facts from his own viewpoint. A comparison of all three might also serve as a starting point for a sermon on the topic "not better, nor worse, but different."

Dr. Hutton became a crystallographer long before the days of X-ray crystal analysis. To him the exterior of a crystal is a wonderful example of the beauties of nature, and a constant stimulus to the crystallographer's curiosity, for from these external forms can be gained a whole theory of the inner architecture of crystals. To one of Dr. Hutton's early training, the results of X-ray crystal analysis are highly important because they offer clear evidence that the old ideas underlying the theory of space groups were sound. His chapter on "The Revelation of Crystal Structure by X-rays" is an excellent short résumé of the Laue, Bragg and Powder methods. Only in a few scattered instances has he placed a little too much faith in statements which he has found in the literature, so that he has at times unwittingly taken pure assumption for fact.

The whole book is written from the historical viewpoint and loses nothing in interest by being a little discursive—for instance, when the author ends a discussion of ice crystals by an account of his ascent on Mount Blanc in a snowstorm, or when he ends the chapter on "Experiments in Parallel Light" by a description of ancient and modern carvings in quartz. The book has twenty-one chapters, which cover the measurement of crystals by the goniometer and by X-rays, the types of crystal structure, isomorphism, polymorphism, morphotropy, optical properties, liquid crystals, etc. Appendices give an excellent glossary of technical terms, and a list of the thirty-two classes of crystals and their distribution among the seven systems of crystallization. The book contains many beautiful illustrations.

Dr. Wyckoff studied crystallography shortly after Professor Laue's discovery of the diffraction of X-rays by crystals. Like Dr. Hutton, he saw in the X-ray method a means of distinguishing, in some cases at least, between the various alternative structures which were compatible with the external symmetry of the crystal. The idea of crystal symmetry is so dominant in Dr. Wyckoff's mind that it was perhaps inevitable that his first chapter should be on "The Symmetry Characteristics of Crystals." It is characteristic of the author that his discussion of this topic is exact, and quite complete. The subject is difficult, but he has handled it well. From the standpoint of a salesman, "selling" his subject to the reader, it is unfortunate that this chapter comes first. The average reader will never finish it. If he substitutes pages 94–97 from Dr. Hutton's book, he can start in with Dr. Wyckoff's chapter two, and finish the rest of the book with pleasure and profit.

Contrary to the habit of some, Dr. Wyckoff takes quite literally the proverb, "If it's in the literature, it isn't so." For this reason, his discussion of the structures of the various crystals contains the cautious statements "seems to prove," "it is said," "is supposed," "it has been stated." The book has fifteen chapters. The first eight deal with crystal symmetry, X-rays, and the application of X-rays to crystal structure studies. The remaining seven deal with the structures of specific crystals. A bibliography, a group of tables for use with the gnomic projection, and a table giving sin θ in terms of tan θ are given in two appendices.

Sir W. H. Bragg had a world-wide reputation as

a physicist before he became actively engaged in X-ray crystal analysis. His son, Professor W. L. Bragg, also had a thorough training in physics. It is natural, therefore, that each of them should see the subject through the eyes of a physicist rather than of a crystallographer. To them it is of interest how a physical agent like X-rays can give us knowledge of the arrangement of atoms in crystals, and how the arrangement, so determined, is consistent with the external symmetry. This takes up, altogether, eleven chapters (diffraction, production and absorption of X-rays, the intensity of diffracted X-ray beams, X-ray spectra and the spectrometer, crystal structure, methods of crystal analysis and crystal symmetry). There is an excellent chapter on atomic forces as determined from crystal structure data, and another on the structure of organic compounds.

The whole book is written in the clear and delightful style which characterizes the lectures of the authors. This is not to be wondered at, for both the Braggs are excellent teachers as well as renowned physicists. The result is a book of fifteen chapters which should be read by every physicist, chemist and crystallographer. They will all find it "a faithful sketch of the subject as it stands to-day."

WHEELER P. DAVEY

RESEARCH LABORATORY,
GENERAL ELECTRIC COMPANY,
SCHENECTADY, N. Y.

SPECIAL ARTICLES

PLEISTOCENE FEATURES OF SOUTHERN NEW ENGLAND

AN article in this journal, of date October 2, by Robert W. Sayles, entitled, "Superficial Factors in Earthquakes," contains the following statement that invites correction and comment.

". . . in southern New England the ice pressure is supposed to have uplifted the land near the terminal moraine instead of depressing it, . . . Thus Long Island, Block Island and the Cape Cod region were higher than now at the close of the Glacial period. . . . Since the ice left New England, about 30,000 years ago, the more northern part has been uplifted and the southern part has been depressed. There has been a kind of tilt, the northern part going up and the southern part going down."

As to the coast and the belt of terminal moraine the statement is incorrect both in fact and philosophy. The coastal region participated in the Glacial depression and in the Postglacial elevation of all the glaciated territory. The evidence is very abundant and not inconspicuous.

Under the generally accepted theory of isostatic equilibrium in the earth's crust it is thought that the depression of the ice-weighted area should have been at least partially, balanced or compensated by uplift of neighboring territory. While the location and character of a zone of uplift, or "peripheral bulge," is not determined, it yet appears quite certain that it would lie beyond the weighted territory, and in this case outside the New England coast. In so far as the downthrow of the glaciated area was due to elastic compression of the earth's crust it appears by mathematical analysis that the depression would extend far beyond the weighted area. Under the theory of isostasy, the subsidence beneath the glacial load was chiefly effected by plastic deformation, the forced migration or flow of deep-seated magma out from beneath the weighted area into the surrounding unweighted territory. The considerable depth at which pressure and heat would produce the required plasticity implies a thickness of the supercrust too great to permit of abrupt and sharp folding, or of a high and narrow bulge. At whatever radial distance any bulging occurred it must have been a wide zone of low elevation.

According to Mr. Sayles's conception the axis of oscillation, or hinge-line, was inland from the moraine and within the ice-weighted area. But it should be noted that the moraine belt was part of the loaded area, carrying beside the marginal ice the considerable load of drift deposit. Conceding that any hypothetic bulge would largely have sunk, in response to the Postglacial rise of the deglaciated area, the fact that no clear proof of such bulging has been found on our land territory argues for a wide uplift of small relief.

This complex and difficult subject in geophysics is discussed in an interesting article by Professor R. A. Daly in the October issue of the *American Journal of Science*. He there suggests that the downthrow of the glaciated area might, possibly, have been produced by a down-punching of the area, with surrounding faulting.

So much for the theoretic, and now for some facts. In southern New England we find many plains of sand and silt of wide extent and high above the sea, which are positive effects of standing water. Some of these water-laid deposits face the sea, and some occur in the terminal moraine. Some geologists formerly thought that these evidences of submergence belonged to an episode of glaciation antedating the latest, or Quebec glacier. Waiving the strong argument against multiple glaciation of New York and New England, the fact remains that these water-produced features are superficial, and the very latest geologic record of the region. They have not been

rriden by any subsequent ice sheet. Any later sheet must have been restricted in its field, and uld have left a conspicuous terminal moraine newhere inland.

Another explanation credited the sandplains to cial waters. The new romance of glacial geology d the recognition of glacial lakes caused some stu- nts to give ice-impounded waters undue credit. lacial lakes" were named in eastern Massachusetts thout any proof of ice barriers or evidence of mming, or of shorelines, or of definite outlets. The ly well-attested glacial water of the region lay in e Nashua Valley, as described by W. O. Crosby. t here we find a capacious valley declining (north- rd) toward the receding glacier front, the only oper relation for ice-dammed waters. Only by vio- nt imagination could any long-lived and effective ter-body be conceived as hemmed in, on the sea- cing slopes, by some queer behavior of the thinning e sheet.

As an example of the high sandplains we may ke the "Sharon Plains," in the southern part of orfolk County, some thirty miles south of Boston. hese handsome and extensive plains are on high round with free drainage in different directions sea- ard. Between Sharon Heights and Foxbury the un- oken gravel plain extends two and one half miles, ith altitude of 285 to 290 feet. The limit of water- ork is clear at three hundred feet, which is the deter- ined marine level in the district. If this occur- ence were unique it might more reasonably be ttributed to some capricious behavior of the ice heet. But it is only one of scores of plains, of ravel, sand or silt, all the highest ones having har- onious and consistent relation in altitude to the up- aised marine level.

There is no conflict nor difficulty whatever if the eologic features are accepted at their face value. nd the New England features must be considered n their origin, character and altitude in correla- ion with similar phenomena in the wider adjacent erritory.

In a series of published papers[1] the writer has recorded the results of long and careful study of the recent submergence phenomena of northeastern America, and has described them with a minimum of theory. The latest paper in the list covers the area now under discussion.

No geologist now ventures to deny considerable uplift for northern New England, the maritime provinces, the St. Lawrence Valley and even of the Hudson Valley. But precisely the same kind and quality of evidence applies to all the glaciated territory. For the reader to whom the geologic literature is not available a brief mention of some of the evidence may be given. (1) On the lower ground are wide areas of water-laid material, usually fine materials, which were laid in deeper water, following the ice removal. (2) Elevated, stratified deposits occur facing the sea. Examples at Gay Head, Sankaty Head, Manomet Hill (east of Plymouth and Highland Light at North Truro. (3) Considerable water-laid and well-stratified beds are found in the terminal moraine. (4) Marine fossils are found in uplifted strata. (5) Perfect horizontality of extensive surfaces, and of conspicuous level skylines, represent wave-work of standing water. (6) Many higher plains, of glacial outwash, mark the summit-level of the invading sea when it laved the ice margin. The Sharon plains are an illustration. (7) Massive river deltas occur in all the valleys declining seaward from the highlands. The summit deltas record the sea-level at the time of their building. These are the most useful criteria for the summit marine level, because they carry that level far inland. Fifteen such summit deltas are located in the paper on southern New England.

The summit features 6 and 7 have remarkable consistency in elevation, rising steadily to over one thousand feet in southern Quebec. They have been the

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[1] "Pleistocene Marine Submergence of the Connecticut and Hudson Valleys," *Geol. Soc. Amer.*, Bull. Vol. XXV, pp. 219–242, June 29, 1914.

"Pleistocene Features in the Schenectady-Saratoga-Glens Falls Section of the Hudson Valley (abstract)," *Geol. Soc. Amer.*, Bull. Vol. XXVII, pp. 65–66, 1916.

"Pleistocene Uplift of New York and Adjacent Territory," *Geol. Soc. Amer.*, Bull. Vol. XXVII, pp. 66, 235–262, June, 1916.

"Post-Glacial Marine Waters in Vermont," Report of the Vermont State Geologist for 1915–1916, pp. 1–41, 1917.

"Post-Glacial Features of the Upper Hudson Valley," *N. Y. State Museum*, Bull. 195, 1917.

"Post-Glacial Marine Submergence of Long Island," *Geol. Soc. Amer.*, Bull. Vol. XXVIII, pp. 279–308, June, 1917.

"Post-Glacial Continental Uplift," SCIENCE, Vol. XLVII, pp. 615–617, June 21, 1918.

"Glacial Depression and Post-Glacial Uplift of Northeastern America," *Nat. Acad. Sci.*, Proceedings Vol. 4, No. 8, pp. 229–232, August, 1918.

"Post-Glacial Uplift of Northeastern America," *Geol. Soc. Amer.*, Bull. Vol. XXIX, pp. 187–238, 1918.

"Post-Glacial Sea-level Waters in Eastern Vermont," Report of the Vermont State Geologist for 1917–1918, pp. 52–75, June, 1919.

"Pleistocene Marine Submergence of the Hudson, Champlain and St. Lawrence Valleys," *N. Y. State Museum, Bulletin*, 209, 210 (May-June, 1918), April, 1920.

"Post-Glacial Uplift of Southern New England," *Geological Society of America*, Bull., Vol. XXX, pp. 597–636 (December, 1919), May, 1920.